CAREER IN COMPUTERS

AJAY RAI

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INTRODUCTION

We are in the midst of a revolution—the computer revolution. The ways in which computers are changing our lives are basic and numerous. They diagnose illness, record the circulation of library books, guide missiles and spaceships, identify ciriminals and stolen property, coordinate air defence, perform accounting procedures, plan classroom methods, and so on. The uses to which computers can be put are becoming truly limitless. Slowly but definitely, computers are becoming an integral part of the operation of our society. Each one of us is affected by them in some form or the other though we may not be aware of it.

Today computers are the fastest growing field in India with the highest employment potential. India has had a late start in the field, yet the progress it has made—measured in terms of annual turnover—has been very impressive. Business in and about computers has been to the tune of Rs 300 crores in 1985 and is expected to cross Rs 1000 crores by the end of this decade. This growth has been due to the present government providing the right atmosphere for growth and also by introducing computers to various governmental departments. We see computers doing important work and saving thereby enormous amount of money and time in government department/organisations like the Indian Airlines, Air India, Indian Railways, Oil and Natural Gas Commission, Indian Space Research Organisation, Bhabha Atomic Rsearch Centre, etc. In whatever department they are introduced, the computers are doing work which is almost as important as the work done by civil servants.

Computers have raised the standard of efficiency of government departments. The repetitive and voluminous paperwork has decreased tremendously. Consequently, the corruption and power which went with file-pushing too have been eliminated.

Slowly but steadily accountability and efficiency are becoming the hall mark of the new work culture introduced by computers. Through this new culture, the computers are able to keep track of the job assigned to office staff, from senior officers to clerks. Depending upon the output, the computer records are updated at regular intervals. Computers are programmed to pull up those who lag behind by sending reminders in case the job has stretched beyond a limit. Senior officers can get an instant feed back on the staff's efficiency through computer print-outs.

The origin of computers

The story of how computers have grown into such giant and efficient taskmasters is a story of the promises fulfilled. It all began with the Industrial Revolution. The euphoria which it produced through such epoch-making inventions as the steam engine and the spinning jenny is still felt. For it revolutionized the very basis of industry giving it a fillip from which it has never looked back. The Industrial Revolution produced machines which added enormously to the workers muscular power, increasing his output manifold. It is said that but for the Industrial Revolution and the machines that it gave the human race could not have prospered much.

Computers have brought with them their own revolution which, though not the same as the earlier revolution, is perhaps more important. For it has completely revolutionized the ways in which man's ability can be put to use. Consider, for instance, the speed with which they work. Computers work on electricity. Since electricity travels at the speed of about 300,000 kms. per second, computers can work almost as fast. For example, a computer can perform 500,000 operations per second and with more accuracy and less cost than what man can do manually.

However, computers were not so efficient and money saving devices as they are now. The first real computer—ENIAC—was a thirty ton 'monster' which operated on valves. This was the so-called first generation of computers. Then came 'the second generation' which used transistors instead of valves and were faster than the first. The 'third generation' of computers replaced the transistors with silicon chips and were more compact and efficient. However, there was a problem. It was

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The Computer

What is a computer?

The word 'computer' is closely related to the words 'compute' and 'computing'. 'Compute' means "to determine by calculation" and 'computing', "determining by calculation". Thus a computer becomes a person or a thing that computes. This is where the origin of computer lies. The first modern computers were evolved for the specific purpose of making repetitious and highly complex mathematical calculations. It all began during World War II.

Though computers existed before this period, the present computer revolution owes its beginning to World War II. For it was during this period that weapons requiring highly specialized and accurate calculations were made. Used in day as well as night, these weapons needed calculation of trajectories so that they could 'see' their target and hit it accurately. This could be achieved only if one was able to calculate the probable place where the enemy would be if located. The split second mathematical calculations involved were beyond human endeavour. The need was felt for a machine which could accomplish this task. The result was the first modern computer ENIAC completed and put into use on 15 February 1946. Though the war had ended by then, the making of ENIAC—the first electronic computer—heralded the revolution whose effects are still being felt. How did we manage before ENIAC ? The human brain—the most complex and elaborate 'computer' in the universe—has been doing man's calculation since time immemorial. It was through the use of the brain that the Egyptians were able to build the pyramids, the Romans were able to build long and straight roads, aquaducts and heating systems and the early navigators were able to sail around the globe. At home, the construction of the Qutab Minar and such scientifically accurate astronomical apparatus as the Jantar Mantar are some of the related examples.

However, the areas where modern electronic computers have proved superior to the early computers are the fantastic speed and accuracy with which they accomplish their calculations and the variety of ways in which they can be put to use. Since modern computers are electronic, they can work at the speed of electricity and since all calculations are done by the machine itself—without any human interference—the calculations are accurate (errors, if any; are due to the human factor). The uses to which computers are put are truly phenomenal. Apart from reserving your seat in the airplane/ship/train, running rail and road traffic, keeping accounts and records, computers are used to run automobile factories, forecast weather, guide and run spaceships, set and print newspapers and book, diagnose diseases, trace criminals and forecast election results. In fact, the variety of uses to which computers can be put depends entirely on the ingenuity of those who use them.

Do Computers have Intelligence?

We now have a general idea of what computers can do. All these activities can be performed by human beings. And while human beings perform these activities they make use of what is known as 'intelligence'. Does this mean that computers too have intelligence, the way we know it? For an answer, we have to consider that which is basic to intelligence—thinking, and what it produces—thought. Thought is, by its very definition, "a peculiarly human activity and intelligence is a human characteristic." To think about the two in non-human context encounters instant opposition. What makes the problem still more complex is the ambiguous way in which the terms intelligence and thought are defined. It is almost like comparing submarines with fishes and airplanes with birds.

As a specialist says, the most rewarding question would be "Do computer systems now exhibit, or will they ever exhibit, behaviour which if exhibited by a human being would be considered intelligent?" To answer, let us see what computers have or can do with reference to this aspect.

(a) **Research applications**

(1) *Playing games:* To know, check and judge whether computers have intelligence, researchers have evolved a number of activities. Foremost among them and perhaps the best known are game playing by computers. Chess, checkers, hare and wounds, etc., are some of the games which have been tried out on computers with much success. As specialists maintain, a game is a complex but well-defined process, offering a convenient environment for study. It enables the researcher to investigate the intellectual process or the development of machine capabilities.

(2) *Conversation:* This is another way to check whether computers have intelligence. What better way to know this than involving it (him?) in a conversation? After all, in job interviews we do essentially the same things to know whether a candidate is intelligent enough for the job. Much the same has been tried out on computers by constructing programmes that can carry on natural language conversation with human beings. One such programme was ELIZA, constructed some years ago, of which some examples are given below. Would you call it an intelligent conversation?

(***Every boy is a person)
(I UNDERSTAND)

(***A finger is part of a hand)
I UNDERSTAND)

(***Each person has two hands)
(THE ABOVE SENTENCE IS AMBIGUOUS** PLEASE REPHRASE IT)

(***There are two hands on each person)
(I UNDERSTAND)

(***How many fingers does John have?)
(THE ABOVE SENTENCE IS AMBIGUOUS** BUT I ASSUME (HAS MEANS HAS AS PARTS) (I DON'T KNOW WHETHER FINGERS IS PART OF JOHN)

```
(***John is a boy)
(I UNDERSTAND)

(***How many fingers does John have ?)
(THE ABOVE SENTENCE IS AMBIGUOUS**BUT I
ASSUME (HAS) MEANS (HAS AS PARTS) (HOW
MANY FINGERS PER HAND)
```

(3) *Problem solving:* Consider this problem: Three missionaries and three cannibals are on one side of a river and must cross it. The only means of crossing the river is a boat that can carry not more than two people. If the cannibals ever outnumber the missionaries on either side of the river, the missionaries would be eaten. The problem is—how to get all the six people across the river without any of the missionaries being eaten. Such programmes have been tried out on computers with success. Also tried are problems concerning the construction of mathematical proofs. Does the success of such applications prove the existence of intelligence in computers?

(b) *Non-research applications*

Computers are used for printing invoices, calculating gross pay, curve fitting, calculating statistics, etc. They are also used in the building of university course schedules (including the assignment of faculty and classrooms) and in the ranking of potential players and analyzing the performance of opponents in various sports and games. They are used to perform medical diagnosis and analyse stock markets. All these activities if performed by human beings would be said to involve intelligence in some form or the other. Does it make computers intelligent? As said earlier, in the absence of a precise definition of 'intelligence', there are no clearcut answers.

(c) *Artistic applications*

Can computers be used for artistic efforts? It is a fact that they have been used to compose and play a great deal of music, write television scripts, poetry and some prose. Though TV scripts tend to be a barren distillation of familiar plots and the prose remains unmoving, the poetry has been found to be startling. This may perhaps be due to the way we have been conditioned by modern poets to expect modern poetry to be. Like them, the computers, too, choose words, phrases and lines at random and string them together to form 'poems' with occasional meaning and movement. The same is true in the case of musical compositions.

Do all these applications make the computer 'intelligent'? It is true the same activities if performed by human beings would be termed as intelligent. There is no definite answer. We can only say that computers do have a great intelligence potential.

The Basic Characteristics of Computers

Whether computers have intelligence is a question better left to the specialists to answer. What will be their future, again, is a question better left to futurologists to answer. However, what does concern us is the nature and basic characteristics of the computer.

Basic to computers is electricity. Since electricity travels at the speed of about 300,000 kms. per second, computers can work almost as fast. For example, a computer can perform over 500,000 operations per second and with greater accuracy and less cost than if done by man. This was not the case always. Before the use of electricity, computers worked through mechanical means. Through wheels, clutches, and gears they performed 'duties.' Numerical operations were performed manually—with the implied degree of errors and inaccuracies.

Charles Babbage was the English mathematician who decided to remedy the inadequacies of manual mathematical operations. He began constructing a calculating machine in 1822. The blueprint that he made is still valid today. He was way ahead of his time and what he really wanted could not be made at that time. What he had in mind was the analytical engine—completely automatic and capable of performing the basic arithmetic functions for any mathematical problem and it was to do so at a speed of sixty additions a minute.

What Babbage had in mind was beyond the technical capability of his time. However, the principle he conceived and the basic conception of computer he had in mind are still valid—the basic premises of the present day computer is still the same. As said earlier, modern computer works on electricity. It is the absence or presence of electricity which is at the base of computer programming where *1* could mean presence of electricity and *0*, absence. Together they made it possible for the computer to make its language understood. For example, if we have to write *MOM* for the computer, let *M* be represented by *000* and *0* by *111*. Thus, *MOM* would be *000 111 000*, and so on. Hence it is the pattern of electrical pulses—presence versus absence, there versus non-there, yes versus no, and so on—which makes computer language a possibility.

The structure: As we have noticed, the principle behind computers is really very simple. Take the structure of an automatic digital computer for instance. It has six essential parts.

(1) *The input unit* which takes in data/instructions prepared in accepted machine language.

(2) *The storage unit* containing anywhere between 1,000 and 50,000 or more registers in which data or instructions can be stored in machine unit.

(3) *The arithmetic unit* which performs additions, subtraction, multiplications, divisions, and other arithmetic and logical operations on numbers received from storage.

(4) *The output unit* which takes computed answers in machine language and translates them into printed characters acceptable to human beings.

(5) *The bus or trunk* which conveys information from one part of the machine to another in the form of electrical pulses, through wires.

(6) *The control unit* which takes in each successive instruction from storage, and issues commands to the switches or gates inside the machine, controlling the connections of the bus with the registers.

Basic characteristics: To be of any use, a computer must have three basic characteristics: Speed, Accuracy and RELIABILITY. Let us take them one by one.

Speed: Computers were considered essential to perform mathematical operations at great speed. Now they have made many scientific and other achievements possible. From the designing and successful introduction of high quality machines to man's endeavour to penetrate space have been possible because computers were there to do enormous mathematical calculations at a fantastic speed. A reasonably fast computer can do more computing work in less than two minutes than a man can do in a lifetime. What is more, the cost of 20,000 operations with the computer is less than seventy-five paise. This is because computers work on electricity and thus are able to work at the speed of electricity which is anywhere about three million calculations per second.

Accuracy: With speed was required accuracy in mathematical calculations. For the one without the other is useless. A calculation done with tremendous speed but inaccurate is useless. Fortunately computers are machines and if they are maintained and run properly they are likely to be accurate. Errors, if any, are mainly due to the human factor—undertrained programmers, insufficient or inaccurate data, etc.

Reliability: The computer must be reliable. Human memory is not reliable. We may know and remember something very clearly today, but forget it completely tomorrow. This is not expected of a good computer. Fortunately, no good computer ever forgets. By human standards the capacity of computers to store data/facts/figures is almost limitless and reliable.

Other characteristics of computers include *versatility*, *automation* and *tirelessness*. To know the versatility of computers, one has only to think of the uses to which the computer has been put. One can see it working in engineering, science, business, industry, and military and government operations; language translations, playing of 'management games' in which two competing teams of managers try out business planning strategies in model business situations, guidance of missiles and navigation of submarines. By automation is meant the ability of the computer to perform its tasks on its own without guidance from the programmer or any other outside agency after it has been programmed for the task. Tirelessness concerns the computer's capacity to work almost non-stop and also its capacity to perform the same task again and again without any change in the quality of tasks so performed. Thus the worth of a computer depends on the number of characteristics it has, and the extent to which those characteristics influence its working.

Development of computers

The modern era of computers began over thirty-five years ago, although the computer itself dates back to before the Christian era. Specialists divide the evolution of computers into four distinct parts:

(1) Measuring devices,
(2) Counting devices,
(3) Logical devices, and
(4) Punched cards.

(1) *Measuring devices:* The development of measuring devices is closely connected with the development of analog computers. Analog computer is a model in which the mathematical structure, describing the operation of its electrical parts, is the same as that which describes the operation of the physical system which is being modelled. For example, any change in the electrical system will also represent the corresponding change in the physical system. One of the first analog devices was made by the Greeks around 1000 B.C. in the form of celestial motion computer which could describe the location and cycles of heavenly bodies. Next in line of development of analog computers was the invention of logarithms, in 1614. After the logarithms came the slide rule, which was invented in 1622, and then the first analog computer, invented in 1915. Next has been the hybrid or combined analog-digital computer. These computers are much in demand by the military which require its services in gunfire control. These steps in the development of analog computers are but broad divisions which give the most cursory bird's eye-view of the field.

(2) *Counting devices:* The first counting device is the most common abacus, which first came in the limelight in about 450 B.C. As in the case of analog computers, the history of counting devices too is divided in some major stages. Some of these are:

After the abacus, the first really significant development of devices was the development of a mechanical adding machine, with rotating wheels to represent the values of the digits and containing a mechanism for carrying from one position to the next. This was developed by the famous mathematician and philosopher, Blaise Pascal, in 1642.

The next important stage of development was 1673, with the invention of a machine by Gottfried Wilhelm von Leibniz. Based on a very simple mechanical movement, this machine multiplied by repeated additions and divided by repeated subtraction.

Then came the analytical engine. Originally conceived as a difference engine, this machine was invented by Charles Babbage, often considered father of modern computers. Babbage, a professor of mathematics at Cambridge, decided to make a machine which could be used in constructing mathematical tables. This need was felt because the existing tables were limited in scope and had a number of inaccuracies. Babbage encountered difficulties from the beginning. The machine was so complex, the nature of its parts so far ahead of the time, that there was not to be found a single person who could undertake to build them. Like a true pioneer, Babbage had to design and build them himself. It was while he was making the parts that he conceived of a more powerful machine—the analytical engine. This completely automatic engine was to perform diverse arithmetic calculations. It was to have five basic parts:

> "—a **STORE** in which to hold numbers, i.e., those which were to provide the information for the problems, and those which were to be generated during the course of calculation."
>
> "—an **ARITHMETIC** unit which Babbage called the 'Mill'. This was to be a device for performing the arithmetic operations on the numbers which had been stored. All the operations were to have been carried out automatically through rotations of gears and wheels."
>
> "—a **CONTROL** unit for seeing that the machine performed the desired operations in the correct sequence and, also by means of a series of gears and wheels, for transferring data between the Mill and the Store."
>
> "—an **INPUT** device to pass into the machine both numbers (the data) and instructions as to which of the arithmetical operations to perform."

"—an **OUTPUT** device to display the results obtained from the calculations."

The engine also had a control mechanism. However, it was not completed during Babbage's lifetime. But the common element between Babbage's machine and the modern computers is very basic. Conceptually there is hardly any difference between the two.

(3) *Logical devices:* These are closely connected with the syllogism. In a syllogism we find a formal argument consisting of a major and a minor premises and a conclusion. An example would be:

(a) Honesty is a virtue
(b) Virtue is admired
(c) Therefore, honesty is admired.

Considerable efforts were put into the mechanization of such deductions and syllogism led to the development of symbolic logic, which in turn led to the development of logical algebra by George Boole. Though more logical devices were invented in this category, it was the amalgmation of logical devices and counting devices which resulted in present day computers.

The first electromechanical calculator, which belongs to the class of logical devices, was constructed by George Stibits of the Bell Laboratories between 1937 and 1940. It used relays to represent information, and was called the Complex Calculator. The development of a device—eventually becoming Automatic Sequence Controlled Calculator Mark 1—by Prof. Howard G. Aiken of Harvard University in 1937 was another important development in this line of computers. It was built by International Business Machines (IBM) in 1944. It used relays, as the Complex Calculator did.

One year after the introduction of Automatic Sequence Controlled Calculator, was completed the most famous computer to date—the Electronic Numerical Integrated and Calculator (ENIAC). The ENIAC was the joint effort of Dr John Mauchly and Presper Eckert of the University of Pennsylvania. The ENIAC was the first fully electronic computer, since it used vacuum tubes rather than relays to represent information.

(4) *Punched cards:* The punched cards were first used in the second half of the eighteenth century in looms to control patterns. By the end of the century, punched cards had been adopted for the task of processing census data. The task of adopting punched cards for census enumeration was given to a statistician, Hermann Hollerith, who was asked to evolve methods which could process census data more accurately and in much less time. His efforts resulted in several card processing machines, in which data were recorded on cards by a card punch and tabulated on a machine that had electromechanical devices. Hollerith's machines reduced the time required in census operation to just one-third of the time taken earlier.

In the meantime, the builders of the ENIAC—Dr Mauchly and Eckert—had got themselves interested in punched cards. They left the university they were working at and formed their own company. Their efforts brought about the introduction of a computer—the Univeral Automatic Computer (UNIVAC). In 1951 the U.S. Bureau of Census received the first UNIVAC. With that began additions to the class of computers in quick succession. In 1953 IBM 701, and in 1956, the first IBM 705, which used magnetic core memory were introduced. The world of computers has never looked back since then, with time, came advancement in computer research and computers started getting smaller and smaller while at the same time their speed and capacity increased manifold.

Computers available today are divided into a number of generations. The concept of generation in relation to computers was evolved around 1964. In the beginning, it was used to distinguish between various hardware technologies. With time, however, it was realised that such a premise was inadequate and the term 'generation' was used to include both hardware and software. Given below are some details pertaining to various computer generations.

(a) *The first generation of computers:* Since the modern computers date from the period when they were made fully electronic, the first generation of computers include those which uses vacuum tubes for the electronic parts and either mercury delay lines or electrostatic tubes for storage. The ENIAC was the first such computer, followed by EDSAC, SEAC, DS, EDVAC, etc., The period covered by this generation was between 1940 and 1952. These computers used vacuum tubes because they were the only available electronic components at the time. The individual components of these computers were assembled manually and it was later found to have the disadvantage of large size, delicate handling, and constant upkeep.

(b) *The second generation of computers:* With time, the drawbacks of the first generation of computers were removed to a great extent and the second generation of computers came into being. The most striking difference between these two generations was the replacement of vacuum tubes with transistors as the main components. Though these too were assembled manually, the use of transistors reduced the size of computers to a great extent. It also made them more reliable and accurate, as well as fast. About the transistors one source says: "Although the transistor was invented in 1948, several years of development and trial passed before it made any real impact upon the computer industry." The breakthrough came in 1954 when the Philco Corporation developed a transistor which was to lead to high speed machines as well as ones with increased capacity. Within four years vacuum tubes were obsolete..."The first all-transistorized computer was the NCR 304. The period covered by this generation of computers was between 1952 and 1964.

(c) *The third generation of computers:* The period covered by this generation of computers was between 1964 and 1971. The most striking feature of these computers was the replacement of transistors with integrated circuits. The introduction of integrated curcuits made the computers still smaller, fast, accurate and reliable. The role of manual labour at the assembly stage diminished, with the consequent increase in the standardization of computers, thus produced. It also allowed for reduction in the cost of computers, with the result, it came within the reach of many buyers.

(d) *The fourth generation of computers:* There still remained a lot of things to be corrected. The use of integrated circuits in the third generation of computers, though an improvement on the earlier models, was inadequate. Much of the work still had to be done. The integrated circuits did not contain as much as they should have or as much as required. Time solved this problem, too. The advent of large scale integration—where over 30,000 components could be packed in a small area of five millimetres square and one millimetre thick, heralded the growth of the fourth generation of computers. Using large scale integrated circuits, they have brought down the cost of computers drastically. They have also allowed for the growth of microcomputers. Beginning with 1971, the integrated circuits have developed much and today over one million components can be packed to the small silicon chip. The era of fourth generation of computers began in 1971 and is still running. Future promises still smaller computers but more functional and capable than they are now.

How does a computer acquire and represent data?

To answer this question, we have to identify and categorize all the units that combine to form a computer. To understand the working of the units, we have to have the general grasp of the internal operations of these units. Also important is the knowledge of how some of these units are used by the overall computer system.

The Off Line Devices

These are the devices which do not form part of the computer, but are necessary for its operation. A simple way to identify whether a particular piece of equipment is an off line device is to ask: Is it directly connected to the main computer? If it is, then that particular system is part of the off line devices which make the computer system and help it perform at the optimum level. Thus, the off line devices may not be part of the main computer but their existence is important for the complete efficiency of the computer. Also, the computer and the off line devices form what is known as information system. The information system has a specific goal to achieve and hence is designed for specific purposes.

It is interesting to note here that what is off line device for one computer may or may not be off line for another. Also, if we try hard enough, we can make any electronic equipment off line device for a computer (electronic, because it is the basic common factor for the existence of a computer), and that includes the common domestic iron.

Which is the most important off line device? It is a difficult question to answer. By many counts *the key punch* is considered the most commonly used off line device today. What it does for the computer is very important. It converts information which is fed in the computer from human readable to machine-readable form. With every stroke that the operator strikes, a punch card receives a distinctive patten of holes into a specific column. It is the particular pattern of holes which means a particular character for the computer.

Next to the key punch is *the card processing device.* After the key punch processing is over, the cards with hole patterns are put into a specific vertical pocket. Here they are separated according to the pattern of holes which they have received. Various machines perform various functions. For example, the calculating punch will read only those cards which have numerical data on them. It will also perform mathematical functions like simple addition and subtraction. In the same way the accounting machine will print the information which is on the punched cards. It will also read and perform the same mathematical operation as does the calculating machine.

The calculating punch and the accounting machine are but a nominal sample of off line devices used with computers. With time they are likely to lose importance. But, taken together, and with conjunction with the computer, they perform almost all the functions required for data processing, the basic function of computers. This makes off line devices important. For it is due to them that commercial data processing has developed to such an extent. It is through the off line devices that an organisation can develop from manual to semi-manual to fully automatic. Thus, unless an organisation instals a completely new computer, it is the gradual development in off line devices which will represent its development of data processing. However, one point must be emphasized. Just as adaptation of off line devices is important for the new computer, so is elimination of old off line devices at the proper time. Their continued use may leave one behind in the race of efficient data processing. It is important to know the extent to which the existing off line data devices can be used and when they should be replaced.

After we have decided on the place of a particular off line device in the complete hardware system, our next task is to know its functions. Most computer systems perform five important functions: (1) Input, (2) Output, (3) Secondary storage, (4) High speed storage, and (5) Control.

The function of *control* is the most important element in a computer. Before it was evolved the computer dealt directly with the other units connected with it. Not any more. The function of control is performed by one or more than one device which are known collectively as *the central processing unit*, or simply, CPU. The CPU has become the centre of the computer from where all the activities of the computer as well as its off line devices are controlled and directed. As a result of the CPU, the direct connection with the computer is no more the direct connection with the computer. It is the connection with the computer through the CPU.

The function of *input*, also known as the function of *data acquisition*, is achieved through a number of devices. The basic element of input function is the reading of data put into machine readable form and then transmitting it to high speed storage, under the over all supervision of the CPU.

Among the most important input devices is *the card reader*. This device has an input hopper where all the cards, previously punched, are put. As the control directs, one of the cards, usually the lowest one in the deck, falls into the card reader. The card that goes in the card reader passes under a set of brushes. These brushes make contact with the roller under the card—through the wholes punched in the card—thereby generating an electric impulse. The difference of time between two impulses is measured in terms of the distance between the holes, with corresponding values understood and recorded by the computer.

In some computers, instead of brushes, there is a mechanism whereby rays of light pass through the holes in the card and activate photoelectric cells. As in the case of the brushes, the difference of time between two activations is measured in terms of the distance between the holes with corresponding values understood and recorded by the computer.

Once the cards have gone through the brushes or the rays of light, they are collected by a stacker and either kept for future reference or destroyed. Depending on the mode being used, a card reader can read from one hundred to over two thousand cards per minute.

In the absence of card reader, one can use *paper tape reader*. A keying device is used to encode data as holes in a tape. The paper tape may be produced in short strips or wound on to a spool. Paper tape is read at speeds of over one thousand characters per second. Though paper tapes have advantages in terms of quantity of records which can be kept in it and which remain together without any danger of their getting lost and/or misplaced, it also has the disadvantage in terms of the difficulties one encounters when wanting to deal with single records, since all the records are in a sequence and it is almost impossible to separate the wanted one without going over all the records coming before that.

The third alternative available for data acquisition is the *optical character recognition*. Optical character recognition devices consist of a document transporting mechanism and a means of scanning the document for data. Most scanning techniques sense light reflected from the document and convert it into electrical signals. The printed characters absorb light and hence reduce the intensity of the reflected light. These devices can read over 3,500 machine printed characters and over one thousand handwritten characters per second. Of the many distinct forms which are available in these devices, the important ones are those that read optical marks usually made by pencils, specially formed printed characters and handwritten characters.

Yet another off line data acquisition device is the *magnetic ink character recognition* (MICR) in which the ink used is made of material among others, which is magnetized or magnetizable. The magnetic effect is achieved by letting the document to be read pass under the device that magnetizes the characters that are contained in the document. Once the document is thus magnetized, it is passed under a reading device, which detects the patterns of magnetization of each character, and lets the computer 'understand' it the way it can.

Key-to-tape system is another alternative available for data acquisition in a computer. Here multiple keyboards are connected to a processor that performs various coding and editing steps on data and writes the resulting data on magnetic tape or disc storage media. Editing here means the preparation of data for processing. This preparation may include such steps as inserting special characters, testing for reasonableness and changing the order of data.

In many ways, the key-to-tape system has many advantages over the other off line data acquisition devices. For example, it allows for direct key to tape connections and removes thereby the time consuming tasks of card handling and reading. This not only increases the efficiency of the main computer but also increases its total productivity.

We have so far considered input devices which involve preparation of data in a particular way before they are fed into the computer. Does it mean that the computer cannot be reached directly through a machine with key-boards? Such a machine, though used by computer operators like a simple typewriter or teleprinter, converts the matter automatically and directly into the computer. Such machines are called terminals.

One of the main advantages of a terminal is that it need not be close to the computer. It can be kept at some distance away from the computer and is connected to it through electric wires. The information to be fed into the computer is 'typed' on the terminal which directly sends it—feeds it—to the computer, situated some distance away from it.

There are terminals that can only send information from the computer. Some terminals can only receive information from the computer. But there are terminals that can send as well as receive information from the computer.

If terminals need to be relatively close to the computer, they are connected through wires. In such cases, by necessity, the distance between the computer and the terminal cannot be more than a few hundred yards. Terminals can also be connected to the computer through remote control. This remote control can be through telegraph, telephone or microwaves. The distance between the computers and terminals running through remote control depends on the purpose and also on the medium which permits connection through remote control. When a terminal is connected to the computer through remote control, it does not necessarily mean that it should be at some distance from the computer. A terminal connected to a computer through remote control may be a few miles away from it or it may be placed next to the computer.

The importance of terminals lies in the fact that it allows for a number of terminals to be connected to the same computer. This enables the computer to be used by a number of terminals, each using the computer by turns, thereby allowing for optimum computer use. This is important since a good computer—if safeguarded against getting heated and/or electric accidents—can work almost continuously. And the extent to which a computer can be used depends on the operators involved in getting the optimum out of the computer.

Terminals are used in tasks requiring inflow as well outflow of information in and out of the computer from and to a number of centres. It is for this reason that terminals are used in tasks like seat reservation by airlines and railways where seat/berths requirement from various centres, situated in the same city or in a number of cities, are 'treated' by a computer situated at a particular place. Other such uses could be—'treatment' of orders from various centres by the computer in the central office of a big company. Stock checking, updating of accounts, and keeping track of criminals are some of the other tasks which have been made possible by the development of terminals which can be connected to the computer—either directly through wires or indirectly through remote control.

Of the many terminals currently in use is the *teletypewriter*. There are terminals small enough to be carried by the person collecting data. This enables the person to feed data directly to the computer as soon as they are collected. This allows for maximum accuracy since data is fed *as soon as* it is collected not allowing it/to be tampered with in any way. Such terminals are very useful in traffic control in big cities, market research, meter reading, etc. There are many more types of such terminals, with almost the same kind of utility found in them.

So far we have discussed the devices used in the acquisition (input) of data by the computer. We now take up the second most important function of a computer, the function of data representation, otherwise known as output.

The basic element of the *output* function of a computer is the transmission of data from high speed storage to specific devices which are directly under control of the central processing unit. Among the devices that are used for data output from the computer, some perform only the output function, while some perform both the input and output functions. Among the devices which perform the function of output as well as input are some of the terminals like the teletypewriter. The emphasis here would be devices which perform the function of output.

Most computers use printers for transmiting data information to specific devices. Some of these printers print out entire lines, some only one character at a time. Some put the characters through impact mechanism, which others through non-impact mechanisms.

A typical impact printer is the line printer which can print over 2,500 line per minute. "This printer prints on continuous forms which are pin-fed past a print chain. Hammer strikes the paper, forcing it against an inked ribbon and against the desired character in the print chain. The print chain is a loop that contains several sets of characters and passes continuously in front of the print hammer."

Though most printers print within the range of more 2,500 lines per minute, some electrostatic—that is, non-impact—printers can print over five thousand lines per minute.

Next to the printer is the *plotter*, which is an output-only device. It produces a hard copy picture from the digital input. "The results of computations are converted into sets of coordinated and commands to the plotter, which then produces the picture."

The computer output microfilm is yet another device which allows for efficient output from the computer. With the use of microfilm instead of paper, the output speed is greatly increased. Moreover, there is a marked improvement in the quality of the output data. An average computer output microfilm can convert digital data to film at the rate of over sixty thousand characters per minute.

A typical computer output microfilm is the page search reader-printer, which can locate a single document out of over ten thousand in an average of five seconds and can give the print of that documents in nine seconds.

Another important output device is the cathode ray tube

(CRT) device. This can be output-only as well as output-input device. The output part of this device looks like a television screen and contains the cathode ray tube. Once the switch has been pressed to activate the electron beam it strikes the screen. This beam is the result of the computer's response to the command and contains the output data, which is shown on the screen through the beam.

The cathode ray tube device can be of two basic kinds: one which presents only characters and is known as Alphammeric, while the other can present characters as well as lines (and pictures made with them). The Graphics—the name given to those devices that present characters as well as lines—are more expensive than the Alphammerics.

Before concluding this section, let us mention briefly, such related topics as: (1) Magnetic tapes, (2) Magnetic discs, (3) Floppy discs, (4) Backing stores, and (5) Winchester discs.

The magnetic tape used in computer is of the kind used in tape-recorders. The only difference is in terms of quality—the tape used in computers is of superior variety. It keeps data in the form of spots, some of which are magnetized and others not, repesenting 1 and 0 respectively. The magnetic tape has many obvious advantages. It can keep data for a long period, can be used a number of times, does not require replacement, does not require data to be erased before recording new data (recording of new data automatically erases the data already recorded) and it is ideal for records which have to be kept in sequence and used in sequence. Another important advantage is the compact way in which data recorded on magnetic tapes can be carried from place to place and also when it is to be used by computers which are not connected with each other in any way. Placing the tape in the relevant slot will provide the computer all the data it requires for a specific job. It is for these reasons that magnetic tapes are widely used both for data acquisition and data representation.

The magnetic discs are similar to magnetic tapes in a number of ways. Both record data in a sequence of magnetized and non-magnetized spots. One difference between magnetic tape and disc is the way in which the data is recorded and accessed. In the case of magnetic tapes data can be recorded only in a serial form, that is, one file is recorded after another file. Therefore, if a particular file recorded towards the end of the tape is required for processing, the computer has to sequentially skip through all the files starting from beginning of the tape till it arrives at the desired one. This type of data access is called sequential access. In magnetic discs random access is possible. A desired file is located by the sectorwise first by the rotatory motion of the disc and then by the radial motion of the reading head. Random access in discs has made them very fast and they are almost universally used with all types of computers.

The floppy disc is an important alternative to the magnetic tape and discs. It is also a relatively newer addition to the group of devices used for data acquisition and representation. Unlike the magnetic disc, the floppy disc is made of flexible plastic and coated with magnetic oxide. It is often packed in plastic cartridges or cardboard sleeves. Like the magnetic disc, the floppy disc can also be used for both input and output of data. The floppy disc is relatively less costly than either the magnetic tape or the magnetic disc. For this reason it is ideal for small, domestic computers as well as word processors.

The immediate memory of a computer—however vast it may be—is limited in size. That place is used mostly for tasks which are current and in operation. Thus the computer's memory is used on a temporary basis and its contents are replaced as soon as the related task is over. Were we to depend on data recorded in the computer's memory, it would limit the scope of the computer to a great extent since each time data is required, it will have to be recorded again and again, wasting thereby both time and resources. In such a situation the very use of the computer will not be viable in terms of resources and manpower.

To remedy this drawback, the concept of 'backing stores' comes into picture. It is through backing stores that data required by the computer is taken for use and reverted back to stores once its task is complete—to be referred to again if the need be. Thus, data is neither destroyed nor underutilized. Backing stores thus become an extremely important aspect of the central processing unit.

Another device used for data acquisition and representation is known by the name of its inventor—the Winchester Disc. Winchester discs are sealed air-tight units. The fact that they are sealed in containers makes it possible to forego maintenance. They are closely related to the floppy discs, and but for the fact of their being sealed, are almost the same. They are, however, more reliable and faster and are heading for the dominant position in the field of minicomputers, word processors and business systems.

Magnetic tapes, discs, Winchester, etc., are all back-up or bulk memory devices.

We have discussed in detail the twin aspects of data acquisition and data representation and have described the devices used in the achievement of these twin tasks. We will conclude this section by referring to the relationship between the devices and the central processing unit. In whatever way we look, the two complement each other. Each needs the other. But for the devices of data acquisition and data representation, the central processing unit would be greatly underutilized. And in the absence of the central processing units, there will be hardly any use of the devices of data acquisition and data representation.

There is another aspect. The speed with which the central processing unit can function is truly phenomenal. The computer works at the speed of electricity and can handle an amazing number of operations per second. Thus if the central processing unit was to work on the basis of the speed of input and output operations, it would remain almost standstill. Imagine, for example, that the central processing unit has to wait after having called for data from a device for its transmission. It will be a colossal wastage. To avoid such wastages, the computer has to be designed in such a way that its central processing unit does not have to wait after having initiated the transmission of data from a device. It immediately proceeds to the next operation. As data comes in or goes out, the central processing unit keeps itself busy with other operations and interrupt its tasks only occasionally to either register incoming data or give out the required data. What we have described just now is known as time-sharing.

As the uses to which computers are put, increases, their operation becomes equally complex. New ways are evolved to eliminate the wastage of time. One such way is the connecting of input and output devices to a third device which is known as a CHANNEL. By using the channel, the central processing unit does not have to contact each and every input and output devices. All it does is to command the channel for the data or reproduction of the results of an operation, and continues with its operations. The channel, on receiving the command, executes it at high-speed and independently of the operations of the central processing unit. In this way the input and output operations proceed concurrently with processing. Once the input and output operation is complete, the channel signals the central processing unit that the assignment is over. The central processing unit interrupts whatever it is doing, attends to what the channel has to offer and then continues with whatever it was doing before being interrupted by the channel.

What is computer programming?

A computer is designed to function on the basis of sequences of commands that it understands. This is the basis of computer programming. For it is through computer programming that we are able to give the command—arranged into specific sequences—which directs the computer to perform a given task. The ability of a computer to treat the given command successfully is known as *stored program capability*. The importance of stored program capability becomes apparent when we realize that in every computer there are areas where it can store the multiple programmes given to it. This storing can be both within and without (in which case it is in the form of cards and paper tapes). Experts maintain that stored program capability is extremely significant when assessing the power and importance of a computer system. Let us consider its two basic advantages.

The stored program capability allows the computer to be both a general purpose machine and a special purpose machine. For example, when the stock inventory program is loaded into the computer, the computer stops its immediate operations and attends to stock inventory. Later, when the stock inventory is over, it reverts to its earlier operations. After sometime, suppose, it is asked to attend to the pay roll program, it will again stop whatever it is doing and attend to pay rolls. Once it is over, it will gain revert to whatever it was doing earlier. And so on.

The stored program capability allows for changes, if any, in the program during its execution since the program is available internally and in a sequence.

Besides these two advantages the phenomenon of *Multiprogramming*, which is the computer's ability to process more than one program at a time, indicates the advantages of stored program capability.

Programming Languages

The commands to a computer must be such that it understands them. In other words, the computer should be able to process them. Only when it can process the messages in its own way can a computer be amenable to human instructions. Any program which satisfies this basic requirement is known as *Machine Language Program.*

Machine language, can then be defined as a set of instructions in a form acceptable to a computer.

Some computers have specific machine languages. For example, the UNIVAC 1108 could/can be programmed only in its specific language, so is the case with IBM System 360/40. It is impossible to 'talk' with UNIVAC 1108 in the language of IBM System 360/40, and vice versa.

Fortunately, this is not the case with every computer otherwise there would be as many languages as there are the types of computers. There are a number of computer languages which do not form part of any specific computer hardware and can be used to 'talk' with computers of various types. Such programming languages include the famous FORTRAN and COBOL. However, it is still necessary for the programmes written in such languages to be converted into the specific computer's machine language.

Development of Computer Languages

In the beginning, computers were wired programs. On the completion of a specific program, they had to be required for the next program. The expense in terms of energy and time, and resources was enormous. Hence, only governments or very big commercial establishments could afford the use of such computers. The introduction of stored program concept changed all this. Things became more and more automatic and time consumed by a computer in the execution of a task decreased steadily.

The concept of stored program owes it existence to a mathematician, John von Neumann, who introduced it in 1945. It was due to the Neumanns' report, containing the basic elements of the concept of stored program, that defined a proposed machine called EDVAC (Electronic Discrete Variable Computer), stimulated the development in England of a machine called EDSAC (Electronic Delay Storage Automatic Calculator). EDSAC was the first stored-programme machine to be completed.

The early computers had only machine languages to be programmed with. There were no programming languages as such. And the machine language could be very complex. For example, G1974 might mean to a machine that the contents of a high speed storage location 1974 be added to the register.

There were other difficulties too. It was very difficult to remember the codes for each operation. It was still more difficult to remember the actual location at which both instruction and data were located. And the most difficult part was time when some instructions needed to be changed/modified.

It is easy to imagine the difficulties in changing instructions. Any insertion or deletion automatically results in the change of the original sequence or the order in which they have been put, necessitating thereby a redoing of all the sequences and/or orders. To overcome these difficulties a number of innovations were introduced. Among the first of these improvements was the development of Mnemonic operation codes in which each code represented a particular operation. For example, the letter *G* represented the operation of addition, which was later replaced by the mnemonic code of *ADD*. Another important development was the introduction of symbolic addressing. For example, instead of referring to 1945 in actual, the programmer was given the names of LOC 7 and so on. However, the original problem remained. Though a number of symbolic operation codes were conceived, the problem of machines understanding their own machine language evaded solution. Moreover, the fact that symbolic operation codes developed led to an intermediate step in the program operation process. For it is important to convert the symbolic operation codes into machine language. Such a programme was called an *assembler* and the symbolic language that is converted by this action was known as *assembly language* program. SAP, used on the IBM 704 was one of the first assemblers.

Thus we recognise here four steps:

(1) The assembler is loaded into the high speed storage of the computer. Each assembly program is then executed with the help of the assembly language programme as input.

(2) We get machine language codes which result from the conversion for mnemonic operation code. This gives us the *object*.

(3) The machine language obtained through step number two, is loaded into high speed storage.

(4) Everything achieved so far, to the program, is executed with data as input.

These four steps lead us to two terms: The *compilation* and the *compiler*.

Compilation is the process through which the source program (obtained through the conversion of the assembly language program from the assembler program) is translated into the object program.

The compiler is the one who achieved this conversion.

As the higher languages developed, they brought with them virtually dozens of distinct systems. We will discuss here only the three most important ones.

Fortran: It stands for FORmula TRANSlation. It is a procedure-oriented language developed by IBM, which though defining it in 1954 could use it only in 1957, in their IBM 704 model. The successful use of this language implies that the operations to be executed must be specified and also the sequence in which they have to be executed. The term procedure-oriented has another implication. When we say that a language is procedure-oriented, we mean that it is related to a specific problem area. Thus in the case of FORTRAN the procedure implied is related mostly to algebra.

The most important advantage of a procedure-oriented language like FORTRAN is its ability to generate multiple machine language commands. This was not the case with earlier languages, which could generate only as many machine language commands as there were instructions of the source programme. For example, in the early languages the letter C could mean only 'add' as command to the machine. In the case of FORTRAN, we may have a statement W=X*2+2*X*Y+Z which means three multiplies and two adds to the machine.

Algol: ALGOL stands for ALGOrithmic Language. It was the result of a report—ALGOL 58. It was the combined effort of a group of organizations through their representatives who got together in 1958 to evolve the specifications of a language which was common to many if not all computers. Thus ALGOL became the first computer language to be designed by a group of organizations rather than a single one.

Though ALGOL is similar to FORTRAN in many ways, it is a much more powerful language than the latter. There are three distinct levels of ALGOL. First, the reference language helps those whose job is to create the various compilers. Second, the level that helps the publication language in forming printed communication both for the computers as well as the programmer. Third, ALGOL has the capacity to be adapted for different hardware systems.

Even though ALGOL is superior to the FORTRAN in a number of ways its use is confined mainly to the European computer users. In the US, it is used mostly in universities.

Cobol: COBOL stands for COmman Business Oriented Language. It was another very significant development in the area of advanced level computer languages. It was born in May 1959 when a meeting was called to find out if a common language was feasible for the business application of computers and also if it was desirable. Predictably, this meeting was called by the Department of Defence of the US (by far the biggest user of computers). Though this meeting was called by a government agency, its participants included representatives of computer manufacturers, computer users, apart from the representatives of the US government. The result of this meeting was the formation of a number of committees. These committees submitted "COBOL—A Report to the Conference on Data Systems Languages, including Initial Specifications for a common

Business Oriented Language (COBOL) for programming electronic computers."

The original report on COBOL has since been revised a number of times. Some of these revisions are known as follows:

COBOL—61
COBOL—61 extended
COBOL edition 1965

ANSI (which stands for American National Standard) COBOL: The greatest advantage of COBOL is the way it can be used through English notations and a form which is narrative—as opposed to the FORTRAN, where it is used in terms of algebraic equation. Consider the following examples:

Example 1: COBOL

```
"IF HOURS ARE GREATER THAN 40.0
THEN GO TO CALCULATE OVERTIME
ELSE COMPUTE GROSS=HOURS*RATE"
```

Example 2: FORTRAN

```
"IF (HOURS—40) 5,5,10
5GROSS=HOURS*RATE
      .
      .
EX 10 . : "
```

PL/1: This is another important computer language. It too was evolved out of the joint efforts of the representatives of IBM and the organization of IBM computers user—SHARE.

The first computer to use PL/1 was introduced by IBM in 1966 together with the first compiler for PL/1.

The main advantage of PL/1 has been its accessibility to both scientific as well as business world which can use it with equal ease. It also removes the shortcomings of both FORTRAN and COBOL.

Problem Analysis: Before programming the computer, two steps must be gone through. These two are:

—Recognizing the problem, and

—The steps involved in systems analysis and design must be completed in which the complete solution to the problem is described in detail. It is only after these two steps can we further program a computer. Unless we are aware of the problem to be solved through the computer and have planned the way to use the computer, we will not be able to program it. Thus in a way, the results of what systems analysis and systems design produces is the most important input for computer programming. Basically, this input consists of the following:

> "A system flow-chart that indicates the flow of information between programmes in the system and the relative position of programmes within the system."
>
> "Detailed layouts of all the data structures that will be referenced by the program. These data structures include input records, required output records, documents, and files."
>
> "A program narrative, providing detailed information on the processing that the program must perform as well as information on the handling of data structures."

It is the task of the systems analyst to give these details to the programmer. It is also for him to draw the limits within which the programmer has to function. Thus the role of the systems analyst is very important for the proper functioning of the computer. We will take up the role of the systems analyst in detail later on. Here, our main concern is computer programming.

Computer programming is done in six distinct steps:

1. Problem analysis,
2. Flowchart program,
3. Coding of program,
4. Testing of program,
5. Checking whether the program is correct. If not, correcting it, and
6. Running the program

Analysing the program is one of the most important steps in computer programming. In program analysis it is imperative that the programmer consider the following aspects of this step:

What are the resources available for construction of the program? Under normal circumstances, there are a number of avenues from which the programmer can get his resources. Foremost among these sources is the computer hardware system itself. It is often the base on which he can implement his program. Other equally important sources are the high-speed storage capacity, the input and output devices, the secondary storage devices, and their capacity. The computer languages are also very essential for the programmer's task.

What are the objectives and restrictions of the program design? When the systems—analyst provides to the programmer the parameters of his job, he also provides him the necessary design objectives. It is on the basis of the parameters that the programmer bases his job and works towards program objectives. He has some liberties in terms of deciding about the objectives. He may decide, while preparing the computer program, that instead of saving on time it is more important to make the program easy and clear. He may also decide that:

> It is preferable to make a program which does not require much storage space
>
> It is better to have a program which is flexible.
>
> It is better to construct the program as a set of self contained and independent modules.
>
> It is better to make a program which requires the least amount of time in its execution.
>
> It is better to make a program which is complete in itself.
> The program should be easy to modify.

The program should also be easily maintainable. *What are the essential requirements for the performance of a program?* The two most important requirements of a program performance are the time taken in processing and limitations imposed for storage. Other requirements of a successful program performance are:

The operator intervention in the operation of a program should be minimal.

The program should be designed to respond to all the possible input conditions.

The output messages produced by a program should be clear and concise.

The program should be such that it performs maximum editing of the input data on its own.

Once the programmer has the resources available to him in full measure and after he has defined the objectives and restrictions which are likely to affect the execution of his task should they be permitted to do so, it is time for him to begin analysing the problem in hand so that he is able to design the relevant program.

The job of a programmer is very exact. He has to make a program in such a way that it produces specific output on the basis of inputs, which too are specific. And he has to achieve his goal without compromising in any way the requirements, restrictions and other demands of his job.

Besides problem analysis, another important aspect of computer programming is *flowcharting*. In its most simple form, flowcharting can be described as "the graphic display of the events in a process". The key word here is "graphic". We know that it is always easier to understand a thing if it is given in a graphic form rather than in a narrative form. Description by words is always more difficult to make and understand than that which is done by figures.

Another aspect of flowcharting is its ability to perform the function of a logic aid. This not only enables it to point out errors in the logical sequence of a possible program, it also results in the more effective grasp of the algorithm flow. The latter aspect results in another important advantage—it allows for the programmer to be familiar with the algorithmic logic, should he decide to revert to it some time, for specific reasons. This becomes significant if a new programmer takes over from the original programmer. But for flowcharting it would be almost impossible for him to "salvage" the programme without redoing it. With flowcharting all he has to do is to study what has been done before his arrival by examining the flowchart.

The development of automatic flowcharting has increased these advantages to a great extent. But "automatic flowcharting takes the form of keypunching the type and descriptive contents of each block presenting this data as input to a programme that simply arranges the blocks on a page with appropriate connectors and prints them...In a more advanced automatic flowcharting technique, the source program is used as input data to produce a corresponding flowchart."

There are some specific symbols used in the construction of flowcharts. These include symbols pertaining to:

INPUT OUTPUT
PROCESSING
DECISION
TERMINAL
CONNECTOR
PREDEFINED PROCESS
FLOW LINE
ANNOTATION

Symbols pertaining to INPUT/OUTPUT: These symbols indicate the function of input or output devices. Connection between high speed storage to input or output devices and specialized jobs like rewinding magnetic tapes are some of the other related functions.

Symbols pertaining to PROCESSING: It represents "any operation other than input or output, decision or termination."

Symbols pertaining to DECISION: After evaluating the criterion of specific situations, the process of choosing one path out of the alternatives of two available, is known as decision. In other words, decision is deciding about one of the two alternatives available after evaluating the criterion on specific situations.

Symbols pertaining to TERMINAL: It simply indicates "starting and stopping points within an algorithm.

Symbols pertaining to CONNECTOR: The main task of this symbol is the representation of entry and exit points in the flowchart. When used for exit the symbol simply means that the processing ends at this point though continuing its journey towards the specific points in the connector. In the same way, when this symbol is used for denoting exit point, it only means that the place where that symbol is situated is a junction where two or more lines of flow come together. However, since these symbols are the same for both entry and exit points, arrows are often used to specify exit or entry points.

Symbols pertaining to PREDEFINED PROCESSES: It "indicates a set of operation, not defined in this chart, constituting a subalgorithm."

Symbols pertaining to **Annotation**: Whenever it is felt that the flowchart requires explanatory notes, it is achieved through these symbols which are added to the points connected with the explanation in any way in the flowchart through dashed lines.

It needs to be emphasized that unless otherwise mentioned, the flow in the flowchart moves from top to bottom and from left to right.

Another very important programming techniqe is **looping**. In its most form, looping is "the repeated, controlled execution of a sequence of operation. A loop will be terminated by the programme when some predetermined condition occurs. The predetermined condition may be completion of a particular number termination of the loop, or it may be the occurrence of an event such as the matching of an element in a table of values."

"In its most useful application, the loop will deal with a large number of values stored in a corresponding number of locations. A loop might be constructed to add 100 values stored in 100 consecutive locations in high speed storage. The loop will accomplish this addition with one add operation together with the other portions of the loop structure, while a routine designed to add these values without looping would require 100 add operations."

There are two basic advantages of looping. First, it is a great time saver. As has been evident in the example above, it is due to the technique of looping that the programmer can accomplish the addition of one hundred values with just one add operation instead of 100 add operations he will have to perform otherwise.

The second basic advantage is the great space saving potential of the looping technique. The space which this programme requires in the high speed storage is virtually a fraction of the space which the nonlooped version will require.

Debugging : Among the tasks of the computer programmer are coding the programme, testing it for possible discrepancies, and if any discrepencies are found then correcting that discrepancy, and testing the programme for the last time before executing it.

The process of testing and correcting the programme is known as debugging. Whether debugging is a minor or major part of the process of computer programming depends entirely on the attention the programmer has paid to earlier steps.

Debugging brings to surface two basic kinds of errors. They are :

The syntactical errors
The logical errors.

The syntactical errors refer to any violation of the syntax of the programming language. They include mistakes in spellings, among other things. These errors are easy to detect by the compiler who brings them to the notice of the programmer through proper error messages.

The logical errors are a little difficult to spot and if remained undetected can affect the validity of the program itself. These errors result from faulty design or analysis on which a particular computer program is based. A faulty design or analysis will provide a program which gives faulty results. It is the error of this kind which give incorrect results of a particular examination. Such errors are extremely difficult to detect and the best way to avoid them still remains prevention. This prevention is best applied at the stage of program analysis and design, flowcharting and coding.

We have thus far covered important aspects of computer programming. Another equally important is the process and technique of systems analysis.

What is systems analysis?

"The term system can easily be misinterpreted. It has a broad definition—an interacting or interdependent group of entities that when taken together form a whole—and thus can be used to cover an entire array of situations. And the concept represented by this term is equally universal. The concept of a system is applicable in physics, aerospace engineering, politics, economics, biology and management to name only a few subject areas."

The system as relevant to the field of computers can be studied through the description and discussion of the following topics, which are related and form together the comprehensive interpretation of this area.

1. Systems analysis and design,
2. The systems analyst,
3. The feasibility study, and
4. The redesigning of the system.

1. *The systems analysis and design* : There are a number of steps involved in the operation of a computer system. These are:

Recognizing the problem
Study of the feasibility of the solution to the problem
Designing of the subsystem
Programming the computer
Implementation of what the computer says
Review and evaluation of the results arrived at.

The first three steps constitute the process of systems analysis and design. In the case of the last three steps, the role of the systems analyst differs from organization to organization. In some, the systems analyst may have nothing to do with the last three steps involved in the operation of a computer, in some, he may be in charge of all the relevant aspects.

In its most simple form, the process of systems analysis and design involves the evaluation and creation of computer based information systems. As is evident from the list given above, the task begins with the recognition of the problem. The problem thus studied may be specific or it may be general. As an example of specific problem can be taken the reason for the late declaration of the results of a particular examination. As an example of the general problem can be the improper recording as for the cause of late declaration of the results of a particular examination.

Whatever be the problem, the next step is to study the feasibility of such a problem. If the results of the feasibility study are positive, the general outline is developed into a detailed design. The programming of the computer is based on the detailed design thus arrived at.

Systems analysis is one of the most crucial aspects of computer operation. It is also connected to the other related disciplines and a number of organizational functions. In other words, it not only plays a crucial role in the operation of the computer, its role spreads on the application of what the computer recommends, and which affects other areas of activities. For example, the process control in an oil refinery includes not only the immediate task of controlling the process of oil refining, it also has as its important elements other aspects like chemistry, engineering, and accounting. Thus any design of the systems will have at least some effect on these fields too apart from the immediate. Hence the success and/or failure of an entire computer system depends on the systems analyst.

2. *The systems analyst* : As a result of the interdisciplinary and interdepartmental nature of the job, the systems analyst is aptly characterized as a generalist. Hence the breadth of knowledge and background implied by the possession of a college degree is an asset.

Another crucial requirement for a systems analyst is his knowledge of computer programming and program. That he must have enough practical exeperience of this area of activities is evident from the type of tasks for a given system into a series of interrelated program, estimating the time and hardware systems, resource requirements for these programs, and estimating the time it will take to design, write, and debug the programs.

Does it mean that the systems analyst also performs the duties of the computer programmer? Not really. A successful programmer need not become a successful systems analyst. This is due mainly to the fact that the skills and general characteristics required for each one of them are not the same. Though most analysts are programmers who have been promoted, they are promoted on the basis of how far they have the basic qualities and qualifications required for the job for which they have been promoted. Systems analysts are generally taken from various application areas and centres which impart specialised training for the purpose of producing well trained qualified systems analyst who should have three basic personal characteristics. It is very important for the system analyst to be able to get along with people. This is important for two reasons. First, he has to draw data from those who are using the present system. Second, he has to convince those who are going to use the system designed by him that what he has designed is really worth going in for, and that that system has greater potential for success in terms of outputs that the earlier one. This ability to go get along with people is the basis which can spell out the success or failure of systems analyst even if he has been able to design the best system

The second basic requirement is the quality of curiosity which the systems analyst must have in ample amount. Whether a systems analyst is successful depends to a large extent on whether he has been able to collect the required data in ample amount. This cannot be possible unless the analyst is really curious by nature.

The third and final quality for a successful systems analyst is the ability to tolerate and appreciate the importance of details. For it is equally important for the analyst as well as those who are to use the system he designs if the system is explained in detail. This cannot be possible unless the analyst "loves" details.

3. *Feasibility study*: The feasibility study determines the computer system suitable for the organization which is to instal the system for the first time. Such a study will find out the elements of fitness in terms of the economics and practicality of the particular system.

However, the installation of a computer system for the first time is not the only reason for the feasibility study. At times, feasibility studies become necessary even when there is a remarkable and significant change in the computer technology and the organization using the existing system wants either to update the system or replace the system altogether, though replacing a system altogether is seldom resorted to, since it involves both heavy expenditure as well manhour involved in the training of the personnel for the new system.

In many cases, the feasibility study is a regular phenomenon and is done at regular intervals to see if the computer system is serving the organization at the maximum utility level.

When the question of constituting the feasibility study team comes, it is important to find out the sources from which the required personnel can be drawn. Fortunately, these limited and easily accessible sources are:

The computer manufacturers who depute some of their specialists for the job.

The consultants who are ever ready to perform specialised services asked for in a study of this type.

Then there are sources in the organization itself. These could be freshly appointed computer specialists as well as the existing staff in the computer department.

After having constituted the feasibility study team, the next important task is to let it know the exact scope for which the feasibility study has to be undertaken. The definition of the scope is primarily the responsibility of those who are either to update the existing computer system or instal a new computer system—the management.

Once the basic formalities of collecting staff for the feasibility study team and defining the scope for which the study has to be undertaken is complete, the task to study the feasibility of a computer system for the organisation begins in earnest. The first step in this direction is the collection of information about the present system in all its ramifications (in case the organization is about to instal an entirely new system and also for the first time, the information would be in the areas of functions for which the computer system is being installed and the human factor which it is displacing). Here the information needed would be:

"Industry background,

"Organization background,

"Organization plans,
"Organization policies.
"Current and projected volume of activity,
"The nature of the current system"

It is while the collection of these information is taking place that the analyst, prepares the first rough model of input-output function of the proposed computer system. As more and more information is fed to him; he elaborates the model he has made. There are times when he encounters information which does not fit the model he has made. In such a case, he can either question the model he has made and if it requires adjustment, adjust it to the information he has. Or, he can question the information which does not fit and find out the inadequacies, if any, and take corrective measures. In either case the fact that he has a model is of great help, because it gives him a starting point and he can improve upon it as new data comes to him.

Apart from the activity mentioned above the analyst must also continue the activities which he is performing in the course of his analysis. These include his indepth study of the requirements imposed on the system he is working on. These requirements may bear upon law, policy, labour, etc.

It must be borne is mind that the designing of a system is a continuing process and the job of the systems analyst is a continuous one. That is, he must continue taking in additional information, modifying his model if modification is required till he has the system required for an organization.

Here, we must bring in another element of the analyst's job. It is almost impossible that the analyst would be designing a system from scratch. In most cases, he has to improve on the system already in operation, thus implying that his job is basically that of redesigning. And in the case of redesigning, the first step is that of definition. "The boundaries and content of the subsystem must be clearly defined. Much of this will already have been done during the feasibility study, although the precise location of the boundary and the supporting details will needed to be worked out. The major problem in system definition is complexity. The system analyst is faced with a bewildering number of operations, documents, inputs, outputs, files, and endless relationships between these elements."

What is the key element of the analysis phase? It is primarily to gather sufficient pertinent information about the existing system to provide a firm base for designing the new system. It is through the collected information that the analyst is able to bring together all the data relating to human, machine and information resources. The importance of these resources lies in the fact that it is through them that the analyst is able to perform his duties efficiently.

The next most important aspect of systems analysis is the determination of the exact requirement that is to be met by the new system being designed. It is for the analyst to decide data to be included in the designing of the new system.

The expectations of the management act as an important deciding factor in the designing of the system for which the requirements have to be worked out. It is vital that to fulfil the expectation of the management the analyst must design a system which has no place for irrelevent data and even less important data are left out. He does this by keeping himself open to all suggestions that come his way, but at the same time he is influenced by them unless they deserve his attention and demand to be included in the system. Objectivity on the part of the analyst is extremely important.

Briefly put, the elements which the analyst must consider while working out the needs of the system are:

"Required operations
"Required data structures
"Required volumes
"Performance requirements."

Ater determining the exact requirement to be met by the new system being designed, the analyst finally comes to the main task involved in systems analysis—the designing of the system. He decides whether what has been done so far is appropriate. This is the part of the task where the new design takes shape where it can be both programmed and implemented. "The designed structure will be an arrangement of computer and mannual steps, data structures, and documents, and the parameters of the design will be drawn from the feasibility study blueprint, the specification of requirements and the available resources."

It is evident that the system designed for the organization would include not only what the organization will gain by its installation but also what it would cost to instal.

The process of designing begins with the establishment of a design concept. If the feasibility study has produced a concept worthy enough to be adopted, the analyst would take its help and do his job. If the feasibility study has not been able to produce any concept, then the analyst will have to come out with a relevant concept based on data that he has been able to collect.

Once the concept has been worked out, the analyst has to develop the relevant design. The guiding spirit after the formation of concept and before the system has really been designed, should be in the context of this question: "Is it practical?" It is extremely important that the system that comes out of this exercise should be practical enongh to be put to use beneficially for all the parties concerned.

After having discussed the subject of systems analysis in most of its important elements, we will now take up the next important aspect in the field of computer—the applications of the computer systems.

What are the ways in which the computers can be used?

The ways in which computers can be used depends entirely on the ingenuity of those who use them. We have listed the variety of uses to which computers can be put.

Briefly, computers can be used to prepare and use mailing lists. They can be used in such complex and vast tasks as space research, in which case almost unlimited amount of data has to be collected, analysed and put in forms in which it can be used. Between these two extremes lie the whole gamut of computer application.

However, there are basically two categories of ways in which computers can be used. These are BATCH and ON-LINE. They refer to the methods in which computers can feed with data. This is because, basic to computer usage is the input of data, without which there can be no output of data.

In batch processing, the computer is given the processing program alongwith the data to be processed. The data itself is collected before it is fed to the computer along with the relevant program. The computer then "treats" the input data on the basis of the program given to it and gives the relevant output to the user.

In on-line processing, the computer is fed with a predetermined program and there is a continuous inflow of data which is processed according to the predetermined program already in the computer. The result comes as the output to the user. However, the continuous inflow of data does not mean that data is fed as soon and in whatever quantity it comes. The collecton of data takes place in this form. The only difference is that it is used in conjunction with the already existing program which is in the computer and each instalment of data is not accompanied by a program. This saves time and also compete utilization of the data ensured. It also facilitates direct linkage of data collection devices with the computer and the automatic "treatment" of data received by the computer—according to the predetermined program already in the computer. The on-line processing is very useful in situations where on the spot, immediate responses are desired.

When and how did computer application develop?

Modern computers can trace their origin to World War II, when the first electronic and large-scale computer, ENIAC, was built. It was specially commissioned by the Ballistic Research Laboratories of the U.S. Army Ordnance Corps and was used by it in calculating trajectories and firing tables.

The first computer was installed in a commercial organization in 1950. It was soon evident that computers were for the commercial world, too, and that a computer system did not affect either the budget or the manpower already working in the organization.

Initially computers were used in the accounting departments, sales department, and other departments where large network of data had to be handled with accuracy. With the advent of communication capability came the on-line processing. Predictably, the first on-line application of computer was also for the military system SAGE (Semi Automatic Ground Environment) which was a huge air defence system developed for the U.S. defence forces in 1950. We will now take up some of the important areas of computer application:

Defence/Space/Science

The first fully electronic computer was built for the defence system. Its role in space and scientific research intricately joined with the defence forces of the U.S. where much of computer development has taken place. Almost all important developments in the field of computers have first taken place in areas which are related in some way or the other to defence department of the U.S. and the percolated down to the business world of that country and the rest of the world.

The major contribution of computers in science and inter alia to the field of defence and space research has been in terms of time saving and accuracy. But for the computer, there would not have been any defence research, space research or any kind of research involving calculation of almost unlimited data.

The phenomenal capacity of computers to handle data has made them indispensable to such scientific fields like physics, chemistry, genetics, astronomy, etc. Seeing their usefulness in these areas, other areas of knowledge like the social sciences, medicine, the humanities, etc., have also gone for computer in a big way.

Of familiar significance to the layman is the computer's importance in the forecast of daily weather. Without computers in meteorology, forecast of daily whether was not possible as data has to be calculated from all over the area covered by a particular study. And this data has to be collected fast enough to be able to calculate and process and make relevant predictions. Today, this information is collected from satellites directly by the computer which "processes" it and enable the specialists to make their forecasts.

In space research where calculations are made in terms of hundreds of places before and after the decimal, human ability would have been awfully inadequate. Then consider the number of parts contained in a spacecraft and all the rest of the connected instruments. They are almost limitless. Running them efficiently or seeing that all of them function the way they are supposed to function and to spot malfunction of even the most simple instrument fast enough and to see that nothing goes wrong would have been impossible for man without the computer.

Industry

Some industries would have been impossible without the help of computers. Take steel for instance. Process control is extremely important in the making of steel in different sizes and grades. It is the accurate handling of the computer which has made steel industry attain the size it has in modern times.

Then there is electricity. Its role in the existence of industry cannot be disputed. And what makes electricity such an impressive agent of power? It is the computer.

The importance of computers for conventional sources of electricity was great enough. Its importance for nuclear power station—today's most important source of electricity and tomorrow's only source—is still greater. Nuclear powerhouses, with their adherence to quality control, time, and production, can not function without the help of computers.

Computers also maintain records of consumption of electricity by a particular consumer, its billing, and most important, the load control which becomes necessary when consumption comes down and or goes up while the production of electricity remains the same and cannot be decreased or increased without loss. This is achieved through computers.

In the case of printing industry, the role of computers is becoming increasingly important. Printing presses, with their emphasis on quality, accuracy in what goes out of the press as the finished product, cannot acccomplish their tasks without computers. International magazines are able to bring out their separate editions—located at places which are thousands of miles from each other—only because they have computers at their disposal which synchronise their intricate operations with accuracy. The operations involved are photocomposing, transit of matter composed, printing, binding, mailing and distribution.

Business and commerce

Computers are extensively utilized in business and commerce. Let us take the computer's role in such diverse, though connected, fields are banking, management, stock exchange, insurance, etc.

Banks deal with figures. Figures are more important to banks than facts. And the computer is basically a computing machine. Hence its application to the field of banking was rather inevitable. It is for this reason that banks were one of the first to make use of computers in their operations. Today, almost every bank depends on its computer for the proper running of its operations.

There was a time when the task of book-keeping, accomplished by the human labour force in a bank. When banking started growing and with growth came expansion of business, bringing with it the necessary growth in the banking operations, human help could not accomplish this task of handling all these operations. Machines were introduced. They helped the banks to grow, which involved still more work. More machines—more complex than the earlier ones—were introduced. And the process went on. Today we can say that computers have been both the cause as well as the effect of phenomenal growth in banking. A growth which has made the world one little banking village.

Another type of financial organisations are insurance companies, finance houses and stock brokerage firms. They are similar to banking in more than one way. And the ways in which they use computers is also similar. The Life Insurance Corporation of India, for example, has to deal with virtually lakhs of policies, involving crores of rupees, every year. It is difficult to imagine it dealing with these without the help and support of computers.

Let us now take computer's role in the successful operation of management in an organization. The basic task of management is simple enough—it has to bridge the gap between information and action, between decision and action, between policy and action. Information collection, decision-making and policy designing need facts to make their task possible. And there can be no better way to collect, classify and "treat" data than the computer. Each and every organization is either using computers in the exercise of its function or is thinking of getting a computer in the very near future.

Two important tasks involved in business and commerce are stock control and maintenance of payroll and personnel records. These tasks involve not only mathematical operations, but also storage of relevant information in the form of data—pay scales, allowances, tax deductions, stock as on a particular day, employment history of the employee, etc.—and in both these tasks the computer is an excellent performer.

Travel and tourism

The computer is increasingly being used in travel and tourism activities. Both travel and tourism have increased in the last couple of decades. This has been due mainly to remarkable development in rail, air, sea, and road travel. Today we have more efficient means of transport in the form of better trains, airplanes, ships and automobiles (cars, buses, two-wheelers). The computer not only lends a very important helping hand in their manufacture (from designing stage to the end product), it also keeps helping their proper use after they come out of their factory.

Consider for instance the relationship between the airplane and the computer. The manufacture of the airplane is a very complex job, necessitating manufacture use and alignment of thousands of very delicate components which made it possible for the aircraft to give security and comfort to its passengers. Such quality control and maintenance of component health would not have been possible without the computer being in the picture.

After the airplane is released from the factory, there is still the question of seeing that thousands of its sensitive components work properly, and malfunctioning of any should be detected at the earliest so that remedial action is taken at the earliest. Such a checking would have been impossible without the help of the built-in-computer that each airplane now has.

The airlines operate from cities to cities and from countries to countries. This involves the whole network of ground control, reservation of seats for the passengers, the food to be served to them on the airplane, ground to air and air to ground communication, etc. In all these activities, the role of computers is most important.

The ways in which the railways can use computers are also varied. From the preparation of time tables to execution of various operations involved in the smooth running of trains (both passenger and goods), the role of the computer has become very important. In cities like Bombay, where suburban trains hold the key to the smooth running of public life, all trains carrying passengers from one part of the city to another, are run and controlled by the computer. The latest use to which the computer has been put is in reservations on important long distance trains.

In some of the major cities of the world, computers are already controlling traffic lights on roads. It is interesting to know that one single computer of the required size can control traffic within an area of about 200 sq. km.

In tourism, we find the necessity of booking hotel accommodation, air and sea reservations, elaborate planning of itinerary, arranging for proper follow up in the places where the tourist has to visit, etc. In all these activities, only computer can make it possible to connect one corner of the world to another. Computers are vital to the growth of tourism.

Public Services

We will discuss here three distinct areas where computers have been applied for proper functioning of public services. There are other areas too. Computers are a great help in the field of medicine. From assisting in the hospital administration to diagnosis of the patient's illness, the computer is increasingly being used with success.

In the teaching and training of doctors and nurses too the computer is being used with increasing frequency.

We have already noticed the phenomenal capacity of computers to store information in the form of data. This storage capacity of computers is of great significance to police all over the world. Recording detailed descriptions of the criminals, proper indexing of fingerprints and most important to be able to give back the recorded information in no time (sometimes the most important factor in crime detection), are qualities that are making the computer the ever faithful and accurate friend of the policeman.

Education

Much of today's education concerns keeping oneself abreast of the ever-increasing human knowledge. The computer data bank is becoming a very important part of today's education. Of major significance has been computer's use in the designing and implementing of academic curricula. Also, computers are becoming an integral part of such scientific courses as engineering and advance courses in the field of chemistry, physics, business and mathematics. What is more, since much of certain type of work can be done by the computer more accurately than by the students themselves, many of the courses have been redesigned to leave for students only with those tasks which add to his knowledge rather than repetitions and mechanical tasks. For instance, instead of becoming expert in the addition, subtraction, division and other simple mathematical operations, the student would do well to concentrate on the nature and qualities of mathematical operations and arithmetical facts and figures.

Communication

Computers are increasingly being used in the running of telephone exchanges. Their efficiency and accuracy is more than their human counterparts were they to handle the same amount of work in the same time.

Another very important addition to computer's role in the proper functioning of communcication network is the introduction of teletext services. These services provide "pages of upto-date information as selected by the viewer by keying in page numbers on a handsized control unit. The services are sent out on the same transmission as conventional TV programmes but a special receiver, or an adopter, is needed to pick up teletext. The services which are free, cover such topics as weather details, travel information, financial news, the industrial news and the exchange rates as they fluctuate, etc."

Politics

Computers have finally arrived as an important instrument in the selection of candidates, election forecastings, keeping trends in the election developments in various parts of the country.

Computers in politics have introduced the interesting concept of voter information. It is true that such concepts have rather a bright future. For they are like market research in which the particular candidate is like a produce and the voter, the consumer. And like market research, which is done before a new product is introduced or when the sales of a particular product decrease and the manufacturer wants to know the reason why. Voter information too would give some fairly accurate results if a new candidate is to be introduced in a particular constituency or if the popularity of the existing candidate is decreasing and the party wants to know the reason why, so that necessary action could be taken.

In the wider perspective, computers are becoming important in the designing a party's election campaigns for the whole country.

These are then some of the important areas of computer application. There can be many more. But narrating them here is neither necessary nor is their any scope for it. Considering the important and representative computer application areas, it is easy to convince the 'non-believer' should he still persist doubting the importance of computers in modern life.

No study of computers, in whatever way it is done and for whatever purpose it is done, will be complete without discussing its social and economic impact. We will take up this aspect in the next section.

The economic impact of computers

Among the reasons that prompt society to accept and go in for something new, in spite of its basic resistance to anything which does not conform to what exists, is the economic aspect coupled with the over (—) all efficiency of the new thing.

Anything to be acceptable must be economically viable. With economic viability goes the efficiency of the thing. Computers fulfil both these requirements. It is common knowledge that organisations and individual go in for computers because they reduce costs and increase profits (in the case of the individual, this profit would be in the shape of more work in the same time). Thus, almost everybody finds using computers profitable.

The economic viability of computers having been accepted, it is rather surprising that many people have different views on the nature of the economic impact of computers, of which there can be the following aspects:

Employment
Organization
Management
Competition
Economic control

Employment

Much has been said about computer's influence on the employment situation. When computers were introduced for the first time on a large scale there was much hue and cry that they will result in widespread unemployment wherever they are used. As things have terned out, nothing can be farther from the truth. Although computers have great potential of displacing workers, the displacement is not the same thing as replacement (which will be another name for unemployment).

Computers gained popularity in the early 50's when the first computer was installed for commercial purposes. The introduction of computers in business and commerce, led to pessimism in terms of computers drawback to creates phenomenal unemployment. As the main argument, defenders of computer were confronted with the labour saving ability of the computer (it does save enormous amount of labour). "Predictions were made of unemployment so widespread as to make the depression of the thirties seem a pleasant joke, of potentially unlimited production by systems of machines with little or no help from human beings, of the eventual production of all goods and services by ten percent of the population."

The result of such attitude led to people feeling conerned about the result of massive displacement of workers due to computers. Side by side the messengers of doom were people who saw in the probable displacement the future when it brought prosperity of the kind never heard before, that society which was so prosperous would be able to support its massive unemployed section.

The section of society which was optimistic about the effect of computers, supported its argument with the economic theory whereby improvement in production of goods (resulting from the introduction of computers) will reduce costs resulting in lowering down of prices and higher level of demand, the higher level of demand resulting in corresponding increase in the production of goods. Higher production resulting in demand of additional manpower, thereby employing those whose jobs were in jeopardy due to the introduction of computers. The argument was almost flawless and was able to convince even the most diehard opponent of the computers in terms of its introduction into the labour market.

Computers have not only replaced workers, they have also brought in changes in the form and structure of employment. It is now widely believed that computers always bring in an element of upgradation of the jobs of the workers whom they displaced. They also make the workers more humane than they were earlier when they had to spend almost their whole lifetime doing the same kind of jobs in a mechanical way thereby alienating themselves from their work, their fellow workers, their families, their society, etc. This was what Karl Marx called the alienated society. This however was an extreme and like all extremes was far from the true image of computer's effect on the worker's job situation.

There is also the point of rationalization. We all know that basic to computer's function is logic. Thus the ways in which computers affect the job structure depends on the extents to which the particular job structure is rationalized. Rationalization here means the logical organization of tasks toward the achievement of specific jobs.

Thus computers affect job structures which are rationalized. They also impose rationalization once they are introduced into the job structure. This imposition of rationalizarion is due to a number of reasons:

The very fact a proper study is undertaken to determine the viability of installing a computer system in an organization will bring out any illogical and poorly organized operations in the set-up but are not visible. No computer can function with illogicality. This keeps the systems analyst and the computer programmer always on their toes so far as ambiguity and illogicality of the tasks are concerned. The have to eliminate these otherwise the computer system will not work.

It is common knowledge that computers are costly machines, costly to buy and costly to run. This automatically imposes on the user the necessity of keeping the operation simple, straightforward and cost oriented. This is true of all the operation directly involved in the running of the computers, and also of all the operations that are not directly involved with the computers but are connected with it in some way or the other.

Organization

The formal set-up of an organization shows only the decision making structure of authority. It may have nothing to do with the functional responsibilities, the location of control, the chain of command through which different strata communicate with each other. Computers bring in some important changes. A computer may be installed at any stage of the hierarchy (mostly it is at the decision making stage, though other stages too can and do have the potentiality of a computer.). However, the question which arises here is: If computer results in changes in the decision making structure of an organization, does this change in its turn, result in the decision making structure going downwards or upwards? As usual, the answer can be "yes", "no", and "maybe".

The first effect could be the raising of the decision making structure. With the computer at his disposal, the manager may be able to take even those decisions which were earlier taken by his subordinate staff. This is because he has at his disposal all the relevant information and can take appropriate decision if the situation demands.

The second effect could be that the decision making structure goes down still more. Since the computer is an important tool in the hands of the manager, the manager can afford to delegate authority to his subordinate since he has all the relevant data in the computer at his command and can use rectify the mistakes of his subordinates in time

Here the computer helps the workers to be displaced to a much higher level than they were before.

Management

A computer has very little effect on the higher echelon of the management because the duties involved here far more varied and routine defying than the activities of the lower echelon of the organization and hence cannot be made to depend on computers. The activities of the management are formulation of goals and objectives of the organization, establishment of policy, development of strategy, planning, motivating workers to work efficiently, and leadership in all sectors of the organization functioning. In all these activities the computer can be of great help in providing relevant accurate data but the act itself is beyond its capability. Thus, while computers cannot manage on their own, they can be a tool in the hands of the management.

Competition

This aspect is closely connected with the computer's impact on management. As computers develop into more and more sensitive, its need will be still greater in the management of organizations. Organizations which are professionally managed (which cannot be possible without the use of computers) have a distinct edge over those conventionally managed in the old ways as far competition is concerned. Organization are no more managed on the basis of intuition and hunches. Rationalization has almost monopolised the field. And all the market leaders in any commercial section are managed with the help of computers, which enable them to remain the market leaders in their respective fields. The days are not far when management would be based on sound analysis through and with the help of computers.

Economic control

With the help of the computers, the economic situation of families, firms, cities, countries, and ultimately, of the world would be controlled much more efficiently than has been so far possible. For, with the development of computers the days are not far aways when we will have all the relevant information concerning the economic aspect of our lives and would be able to concentrate our attention on the areas of deficiencies while at the same time enjoy the fruits of our labour from the areas of surplus. And in time, enjoy of everything in plenty in all the fields of economic life.

These then have been some of the points concerning the impact of computers in the economic life of our society. We will now take up the impact of computers on social life.

The social impact of computers

Though the economic aspeet of life is closely connected with the social aspect, it is almost impossible to discuss one without in some way discussing the other.

When considering the social impact of computers, we must remember that the computer is a relatively recent addition to our society and its full impact on society is still to be studied and analysed fully. The social impact of computers can be in the following areas:

The individual and the problem of Privacy
Politics
Education

The individual and the problem of privacy

Man has been awestruck by the computer. We see, read and hear fearsome portrayal of life in which computers would run human life, in which man would lose his individuality, and become an instrument of the computer just in the same way in which the computer is the instrument of man. This almost baseless fear in the layman, takes two basic forms: The fear that is anthropomorphic in nature; and the fear that is represented by a dehumanization of life quality. The anthropomorphic fear is characterized by the thought that computers would in time become so powerful that they will exercise their superiority in much the same way in which man is exercising his superiority today. People with this fear see in future computers showing signs of human will and intellectual independence and dominating the world by ruling over man.

However, there is a silver lining. All the anthropomorphic fear of the computer is confined to those who have nothing or very little to do with it. For those who are actively involved in the manufacture or running of the computer, never show any such fear whatsoever. Thus, we will never find a computer programmer who is afraid of the computer. This is a welcome fact. For it tells us that the authropomorphic fear will disappear once people become familiar with it and are able to see and find out what it exactly is.

The fear of dehumanization has in two basic forms: Fear that individuals identity will be lost; and a fear that the environment within which one must function will become impersonal.

The fear of losing ones identity is strengthened by the fact that computers know their facts through numbers and can identify whatever they have recorded only in numbers. Thus, details pertaining to the individual are always referred to in numbers and identify an individual by number. This is anathema to the individual who wants to be identified by name and other such details instead of by numbers.

Then there is the fear of the invasion of privacy. Man's privacy has been threatened from the day Industrial Revolution started. With inventions like the telephone, etc., man started a chain of events the effects of which he is facing today. The threat to his privacy as emanating from these effects are: electronic evesdropping, personal investigation, psychological testing (which tells things about an individual of which he is himself unaware), etc. However, the ways in which computer affects the privacy of individuals is a little different. We all know that the computer does not infringe on the privacy of individuals on its own and intentionally the way electronic evesdropping does. No information about individuals emanates from the computer. It is basically the collector of data which is fed into it. What is more, by knowing and identifying individuals whose personal details are recorded in it, only through numbers, the computer makes the individual anonymous. By making him anonymous, the computer helps in the preservation of his privacy more that anything else. Thus, the fear that the computer would infringe on the privacy of individuals appears to be unfounded.

Politics

We have referred to this aspect when discussing about computer application. We will discuss here the dangers inherent in the use of computers in politics if no proper safeguards are taken.

The first danger is the element of change in the very concept leadership. If politicians start obeying the computer by following what the analysis done on it tells them to do, the politicians would cease to be leaders (which they should be) and would in fact become followers (which they should never be). One can see that the temptation is great. By following the results of computer analysis in terms of what the majority want the politician to do, he may be playing safe, but is he being honest to his station in life? By replacing the process of evaluation of issues involved in his election, by replacing debate and by replacing leadership with following current public opinion, he may want to retain the status quo but is that what politics is all about? Politics is to give leadership to society. And it can fulfil this obligation by following public opinion of the majority, for it is well known that the majority view is never creative, is never the one to want a change in the status quo.

The second disadvantage is in term of exclusive utilization of the computer and what it can offer by the ruling party in a way which guarantees almost indefinite rule by that party at the cost of opportunities which are opposition's and if given to them would certainly result in their coming to power. The key to success in any field today is access to exclusive knowledge. The ruling party has the opportunity to get all the information about what affects it and by following the dictates of the computer analysis based on these facts it can with some imagination remain in power almost indefinitely. This can be done only if certain crucial information is withheld from the opposition, and to the advantage of the ruling party.

These then are some of the important aspects of the computer's impact on the economic and social life of man. As we mentioned earlier, the full scope of this impact is yet to be realized. The picture will become clear with the passage of time.

Important computer languages

No book on computers can be complete without the description, howsoever brief, of some of its important languages. We have made it clear in the beginning that this book is not a training manual and so we would not discuss these languages with a viewpoint of teaching them to you. Our endeavour is just to introduce you to these language and leave the rest to the time when you will actively prepare for the field, after you have made your initial choice.

We will take up the following most important computer languages used by majority of computer users.

FORTRAN	(FORMULA TRANSLATOR)
COBOL	(COMMON BUSINESS ORIENTED LANGUAGES)
ALGOL	(ALGORITHMIC LANGUAGE)
PASCAL	
PL/1	(PROGRAMMING LANGUAGE 1)
RPG	(REPORT PROGRAMME GENERATOR)
BASIC	(BEGINNERS ALL PURPOSE SYMBOLIC INSTRUCTION CODE)

Basic

This is a language most suited to situations where the same computer is used by a number of people who are not the owner. This use of computer by a number of people is made possible by the concept of time sharing, where people pay for the time they take in using the computer without actually owning it.

Time sharing cannot be successful without a language flexible enough and at the same time accurate and scientific enough to be effective. Such a language is BASIC. It was developed by John Kemeny and Thomas Kurtz, two professors of Dartmouth College in the U.S. in the mid-sixties. The basic purpose of the development of BASIC was to make time sharing possible. For that the language had to be flexible and reasonably powerful and at the same time simple enough to be learnt in a few hours of study. Again, any language which was to make time sharing possible had to be computer user oriented. Such is this language. It is useful to those who are new to computers and cannot or would not learn complex programming techniques. The BASIC has very few grammatical rules which are easy to follow. It is for these reasons that most of the people using or about to use computers, learn anything else. The BASIC has much resemblance with FORTRAN, another very important computer language.

Fortran

It was developed in 1956 to be used in the IBM 704 model computer. It was the first high-level computer language. The basic nature of this language was to make scientific problems and mathematic problems accessible to the computer through the use of simple English with mathematical expression. For example: A=BxC—D.

With time FORTRAN was adapted to a number of computer models apart from the one for which it was developed. This adaptation needed some minor changes and the language got revised a number of times. The revised versions of FORTRAN were known as FORTRAN II and FORTRAN IV. With so many revised versions available, the situation threatened to get confusing. The American Standard Institute decided to standardize the language. As a result two versions were finally approved and were known by the name of IBM FORTRAN IV and ASA BASIC FORTRAN. The popularity of this language grew to such an extent that most of the computer manufacturers conformed to the requirements of this language and revisions which were available of the language.

Cobol

It is the most widely used commercial computer language. It was developed in 1958 by the US Department of Defence in its endeavour to find an international business language which could attend to the commercial problems which the Department had to handle in its day to day transaction. The basic need to be fulfilled by COBOL was easy understandability and easy proficiency of the language even by persons who were complete novices to the field of computers. Inevitably, such a language had to be almost like English, which COBOL is. However, it has tended to be very verbose instead of crisp, as a computer language should be and has not been as successful as it should have been. Still, COBOL is as of now the most widely used commercial language for computers.

Algol

ALGOL stands for Algorithmic Language. It was developed in 1958 and was known as ALGOL 58, a revised version was developed in 1960 and was known as ALGOL 60. This too was developed for the solution of scientific and numerical problems and was similar in many ways to another language developed for the same purpose—FORTRAN.

However, there were some differences. While FORTRAN had been basically a language which paid more attention to the simplicity of the language, ALGOL (specially the ALGOL 60 model) paid more attention to the scientific discipline in the programming procedures. Structural concepts and a precision of language definition were the other two characteristics.

The popularity of ALGOL is more in the European countries than in the US. It is so because the US has stuck to IBM language while the Europeans have evolved their own computer models.

PL/1

PL/1 stands for Programming Language 1. It was developed around 1960 when there were a number of programming languages available, each with its special characteristics and specific ways in which it could be used. Such a wide variety of languages tended to make the choice of a computer language very confusing. For example, "for numeric work there was FORTRAN and ALGOL; for systems programming some assembly language would be preferred; COBOL was used for commercial applications, whilst for more specialized applications such as list processing or string manipulation, there was LISP or SNOBOL."

To remove this confusion Programming Language 1 was developed. This was essentially an endeavour to evolve a language which could be used in any kind of application. To get a language of that dimension, the language which evolved out of the exercise was too cumbersome and enormous in its scope. It could not be comprehended by a novice easily, and could not be used by all. What is more, PL/1 was developed by IBM and its use was confined to the machines developed by IBM. Computers of other manufacturers could not be used with the help of this language.

Pascal

It was developed in 1968 and was used for the first time in

1970. It belongs to the family of ALGOL and is flexible enough to allow the programmer to manipulate it according to his requirement. It is for these reasons that this language is used much in the teaching of computer programming to novices.

RPG

It is a popular commercial language and a specialized language at the same time. It was developed by the IBM corporation and introduced for the first time in 1961. In the initial stages it was to be used exclusively in the machines developed in IBM. But later other manufacturers too started adopting it to their machines.

In this section we have explained some of the more important computer languages used currently. We have not gone in for technical details of these languages for the simple reason that it is not required at this stage of our study of computers and what they have to offer in terms of careers. We will take up in our next section some of the important trends and projections which future has in store for us as for computers are concerned.

The future

The way in which computers have been developing in the last few decades is a good pointer to the ways in which they will affect our future. There are certainly going to be some significant developments. We have already almost conquered distance and are able to see live coverages of important sports matches, political meetings and other such incidents which are bound to affect us in some form or the other. However, such developments are the offshoots of basic developments in the computer field both in its hardware as well software areas.

There was a time when computer hardware held people in awe. It was something to be respected and held at a respectful distance. Such was its importance. Not anymore. Today equally important are areas such as personnel, training, software and the conceptual foundations of information systems.

There has been a change in the perspective of the professionals, regarding the relationship between the computer and the application area. In the beginning the computer was the fixed thing, and the problem before the user was whether to present it to the computer in the "proper" way or whether it needed some changes before the computer accepted it. This has changed to a great extent. Now there are program packages which are accepted by more than one computer of varying kind. Today the organization which instals the computer and the needs which it wants to be fulfilled by the computer are fixed. The computer therefore has to mould itself to the organization and its requirements. And this change is bound to be more pronounced in the future than it is now.

There are specific areas in which past performances point towards future trends.

Hardware

We have seen that computer hardware has consistently been advancing in the direction of speed and accuracy with which it can perform its operations. "Cycle times of milliseconds gave way to microseconds, and microseconds became nanoseconds, which in turn have been eroding steadily. The ultimate barrier to speed appears to be the speed of light, approximately 1 foot per nano-second (one nano-second is one billionth of a second)."

Another important area of significant development has been reduction in the cost of computers. Time was when computers cost so much that only governments with their almost unlimited resources, or giant organizations could afford computers. This situation has changed to a large extent. Today computers have become affordable even for individuals. Such is the variety of models available and the reduction of costs of computers. This trend is likely to continue and the day is not far when computers will become common and the uses to which they can be put will increase.

Software

There is confusion prevailing in the instruments available in the software area—too many programming languages, too many programming techniques. With time however this is bound to change. The lack of standardization—in both quality and performance—which is woefully low now is certain to be replaced by proper standardization and improvements. As people become more aware of computers and what they can offer, there is bound to be improvement in standard and quality.

First would be the development of easier to use programming languages of the kind which could be used by non-professionals with the same ease with which they are used by professionals. However, this will not be at the cost of scientific accuracy and application. We are not far from the day when the computer would be used by a layman almost as competently as the specialist. The difference would be only in terms of the ways in which the computer would be used. The specialist would obviously know more ways to use the computer than the layman.

Employment

We have seen how the computer, instead of rendering people jobless, provides more and better jobs. As we mentioned earlier, the need for computer professionals is going to increase manifold in our country. So much so that by the 1990's Indian is going to need over 2,00,000 computer professionals *every year*, for a long time to come. But this need will be for professionals of specific areas. The computer programmer will have to specialise in a particular language and technique. Thus one will have to choose the area for which one has more inclination and then train properly in that area.

The future computer world will need plenty of professionals that is certain. What is not certain is the area in which these professionals would be needed. Thus one has to study the areas of promise in the field of computers and then train oneself in that area. A discerning person who is ready to think logically and who likes solving problems, has a promising future in computers.

The fifth generation computers

This is the computer which will change the world like no other computer. It will be the result of technology which is moving out of research laboratories and into the open market of computers. This will give us computers which will go beyond being exceedingly fast calculating machines to machine's which would be capable of mimicking human thought processes. "Computers with the capabilities to reason, make judgements and learn are on the horizon. Already computer systems displaying some degree of artificial intelligence exist and are used to perform tasks once thought to be the sole province of homo sapiens such as diagnosing lung diseases, locating mineral deposits and siting oil wells."

Artificial intelligence will change the face of the world. The day is not far away when computers will be able to manage offices, factories, medical and military organizations and inevitably our homes.

The concept of the fifth generation computers took off in 1979 when a committee was established by the Japanese government to work out the priority in the field of computer research for 1990s. The report of the committee is known as the "Fifth Generation Computer System". It studied the subject most elaborately and came out with some telling conclusions pertaining to what computers belonging to this generation would do and the basic factors behind these computers.

Obviously, the most important factor connected with these computers had to be easy accessibility so that it could be used easily and naturally. Second most important factor was the development of systems in which problems could be solved easily and accurately. Inevitably, it had to develop what we now know as artificial intelligence through which the fifth generation of computers would be able to behave almost like human beings. Briefly, this generation of computers would have the following functional requirements:

> "Ease of use through computers with high 'intelligence' and natural human input and output mechanisms;
>
> "Reliable and efficient software development by languages, new computer architectures and systems software which overcome previous problems with software development;
>
> "Improved overall functions and performance aimed at making computers smaller, lighter, faster, of greater capacity, more flexible and more reliable."

For proper research of artificial intelligence (known as AI in computer parlance) three areas were to be given special attention:

Development of computers which perform the duties of a manager on the basis of knowledge stored much in the same way as human managers perform their duties on the basis of knowledge which they have collected.

Development of computer which could solve problems on the basis of logic and inference much in the same way as humans are able to solve most of their problems.

Development of computers which could have their own language natural enough to be equally effective when they dealt with humans.

Considering these areas of special significance, it was inevitable that the language to be used by computers would be identified. Such a language was give the name of PROLOG (PROgramming in LOGic). The logic which the fifth generation computers were to use was in the form of mathematical logic, developed by Professor John Robinson of Syracuse University in the U.S. At the centre of this logic was deductive reasoning which is used in majority of human actions.

Though the logic to be used by the fifth generation computers was developed by John Robinson, the actual language—PROLOG—was developed in the 1970s (by two teams, one at the University of Marseilles and the other at the Edinburgh University).

Three of the main tasks which would be accomplished by the fifth generation computers would be:

1. Programming which would be completely automatic and on its own based on data in hand and the instructions as to what is to be done by the computer.

2. The basic architecture of the computer would undergo changes where instructions would more widely distributed than now. For example, today the central processing unit is the centre from which all the actions of the computer are coordinated. This though very useful in the case of present generation of computers, would be a liability in the future generations when computers would be doing much more diverse tasks than what they are doing today.

3. The computer would develop and also verify the authenticity and accuracy on its own without human interference.

Thus, the output given by these computers would be of a much higher level than it is now.

Some of the basic characteristics to be fulfilled by the fifth generation as well as all the future generations of computers, as identified by the committee established by the Japanese government, are:

1. *Reliability:* All future generations of computers will have to be more reliable than they are now. This would involve the computer's ability to detect, correct, improve and implement corrective measures on its own, without any support or help from their human operator.

2. *Speed and capacity*: The future generation computers would inevitably be faster and will have infinitely more capacity than that held by present computers. You can have some idea as to the extent to which these computers would fulfil these requirements by considering the following goals, which the future generation computers are expected to fulfil. A small computer, made for individuals, would be able to attend to over four million instructions *per second.* Imagine then the speed of bigger computers designed to be used by organizations and governments. Translation of thousands of words with over ninety per cent accuracy, per second. Recognizing and "comprehending over 10,000 words spoken by hundreds of speakers" at the same time.

3. *Cost and performance value*: With each successive generation, the cost of a computer will become less so that sections of society which cannot afford a computer now would be able to do so in future. Since individual needs are fewer and smaller and simpler, computers designed to meet the needs of individuals would be smaller and simpler than those designed to meet the needs of organizations, firms and governments.

In addition to the above characteristics, there would also be the question of security since the phenomenal popularity of computers would also open them to specific crimes. Thus future generations of computers would also have to "worry" about their security. This will be the beginning of a new world of computers.

Some important abbreviations

AI : Artificial Intelligence

ALGOL : ALGOrithmic Language
APL : A Programming Language
AU : Arithmetic Unit
BASIC : Beginner's All-purpose Symbolic Instruction Code
CAD : Computer Aided (or Assisted) Design
CAI : Computer Aided (or Assisted) Instruction
COBOL : COmmon Business Oriented Language
CPU : Central Process Unit
DDP : Distributed Data Processing
DP : Data Processing
DPM : Data Processing Manager
EDP : Electronic Data Processing
FEP : Front End Processor
FM : Frequency Modulation
FORTRAN : FORmula TRANslation
Hz : Hertz
IC : Integrated Circuit
IFIP : International Federation for Information Processing
I/O : Input/Output
LISP : Logical Inference Per Second
LSI : Large Scale Integration
MICR : Magnetic Ink Character Recognition
MIS : Management Information System
MSI : Medium Scale Integration
OCR : Optical Character Recognition
PABX : Private Automatic Branch eXchange
PBX : Private Branch eXchange
PCB : Printed Circuit Board
PIN : Personal Identification Number
PL/1 : Programming Language 1
PROLOG : PROgramming in LOGic
RAM : Random Access Memory

ROM : Read Only Memory
SCL : System Control Language
SPC : Stored Program Control
SSI : Small Scale Integration
TP : Transaction Processing
VDT : Visual Display Terminal
VDU : Visual Display Unit
VLSI : Very Large Scale Integration
VRC : Visible Record Computer
VS : Virtual Storage
WP : Word Processing

Glossary

accumulator : The section of the arithmetic and logic unit where arithmetic operations are carried out.

address : The way in which a particular location in computer store is referenced.

ALGOL : A high level computer programming language suited specially for scientific application.

algorithm : A set of rules involved in the performance of a particular task.

alphanumeric : This involves not only numbers, but also alphabetic letters, punctuation marks and other symbols.

analogue : This represents numerical values by changing physical qualities in a continuous way.

APL : Much used in engineering, commercial work and scientific operations, this computer language is very efficient and of high grade.

application : The task performed by a computer at the command of an operator.

architecture : The design showing interconnection of various parts in a computer.

ALU : Arithmetic and Logic Unit, is the part of the computer where arithmetic and logic operations take place with the help of accumulators and special circuits.

artificial intelligence : This refers to the study of how computing—the basic operations of the computer—can be used to perform tasks involving intellect, logic, deduction, etc., in much the same way in which human beings solve their problems.

assembler : This is used to translate a low level language program into machine readable form.

assembly language : A type of computer programming language, of a low level variety. It uses memory instructions and symbolic addressing.

availability : This pertains to the time the computer is operational.

backing storage : The information used as a backing to the main memory.

back-up : Data which is not part of the main information bank but is kept to give a backing to the computer, should the existing data in it be inadequate or incorrect.

BASIC : This is perhaps the most easy to use and easy to learn computer language, used mostly in minicomputers and by novices who wish to learn computer programming.

batch processing : Data precessing in which the input is gathered in batches and is used in batches. This allows for emphasis, should a need arise.

binary : A two state system, represented by the digits '0' and '1'.

bit : Binary digit. Taking the value of '0' and '1'.

byte : A group of eight bits.

cartridge : Contains magnetic tapes or discs.

cassette tape : Stores data used by the computer.

central processing unit : The main control unit in many computers following the von Neumann architecture.

chip : Any piece of material—mostly silicon—containing integrated transistor circuits.

COBOL : A high level language used in commercial applications.

compiler : Software which translates high level languages into machine code.

core : Main memory of a computer.

floppy disc : Used for storing data in the computer.

flowchart : Gives a step by step account of the data processing done by a computer.

FORTRAN : The first really effective computer language which made it possible for computers to be used for different operations instead of being rewired for specific applications, again and again.

hardware : The physical equipment of a computer system.

heuristic : A method of solving through 'trial and error' instead of a preconceived methodology.

informatics : Information technology,

input : Data put in the computer for processing.

integrated circuits : The components in these are chemically put on and 'fixed' on a piece of semi-conductor material. It was through integrated circuits that the third generation of computers was made possible.

megabyte : One million bytes.

microsecond : One millionth of a second.

nanosecond : One billionth of a second.

primary storage : The main memory of the central processing unit.

program : A logical sequence of commands which the computer is ordered to obey to complete a given task.

secondary storage : Memory bank not part of the computer, though it can be referred to if needed.

simulation : When real situations are represented in the computer through 'models', it is known as simulation. Simulation facilitates study and comparison of different situations without actually undergoing them.

software : The collective activities which allow for the computer hardware to perform tasks and to be used to maximum advantage.

specification : Any detailed statement which specifies software or hardware requirements.

system : The composite of software and hardware of a computer, which interact with each other to make computer application possible.

systems analyst : A specialist who studies the computer requirement of an organization and then proceeds to design the program which can fulfil those requirements.

teletext : A form of videotext, disseminating information by broadcast transmission to receiver devices such as the television.

terminal : A mechanism which makes it possible to perform the activities of input, output, and communication with a computer system without actually being connected with it.

2

Computer Courses

Apart from being a graduate a new entrant to the field of computers must also have some basic training in computer programming and maintenance. This is an essential requirement for entry in the majority of cases. Unless the field is very specialized or too low in terms of computer requirement, this seems to be the very least requirement a person has to fulfil if he wants to enter it. Fortunately, with every passing day, newer courses are being offered by both government as well as private institutions. Though we cannot vouch for the authenticity of private institutions, the government institutions are by their very nature authentic and recognised by employer of computer professionals.

In this section, we will introduce you to some of the government and private institutions and tell you what to expect from them in terms of training in computer professionalism and how they are likely to affect your career prospect in this field. We will also discuss the comparative importance of government and private institutions and show the reasons for the mushroom growth of private institutions of computer training.

If you open a newspaper today you are likely to encounter a number of advertisements both from government as well as private institutions, telling you about the special aspects of their courses, and the effect the course is likely to have on your career prospect. Though government institutions tend to be highly subdued in this aspect of selling their courses because they are already much in demand and their is a great competition for entry to such training institutions, the private institutions do not have any such limitations and are very vociferous in telling you about the merits of their courses both in terms of training competence and placement after you complete the training, should you choose to take up their course.

Moreover, training in computer programming, or any other similar aspect of the field, is becoming increasingly popular. More and more people are electing to take up a computer course of some significance as an additional qualification, alongwith their graduate qualification. It is true that some training in computer programming or any similar aspect, is becoming almost as common as learning to type or to know shorthand. With the increase in the demand and its consecutive effect on the supply of computers of various shapes, sizes and capabilities, such trained personnel are going to be much in demand in the near future. What is more, with the advent of minicomputers, computers are going to be almost as popular as the common typewriter has been. This, in its turn, will create the need for choosing a relevant course which will train people to use their computers, or to take proper work from those who are employed by them to run the computer. Thus, some training in computers (whether it is programming or maintenance, is of little consequence, for the one automatically leads to the other) will be essential for not only those who are looking for a career in the field of computers but also who may not run the computer but who would employ computer professionals to run their computers. In other words, whether it is the employer or the employee, training in computers will be essential.

Computer courses are offered by government bodies as well as private institutions. Since the government is the body which allows or refuses to allow introduction of new technology, it is the government which initiates training in a new field growing out of the introduction of a new technology. Such was the case with computers. Among the first specialised courses in computer technology were the B. Tech. and M. Tech. degrees offered by the IITs, to begin with, and later by other government institutions.

The competition for entry to the courses offered by the premier institutions, leading to the degree of B. Tech. and M. Tech., is extremely tough. One has to be in the top fifty selected candidates on the basis of the merit list prepared through the Joint Entrance Examination each year.

Apart from the IITs, seventeen other institutes offer B. Tech. degrees but the courses run by Indian Institute of Science, Bangalore, Birla Institute of Technology, Pilani and the Regional Engineering Colleges are highly regarded. Computer science is also available as an elective subject in electrical and electronics engineering. Students doing these courses are prepared for research and development as well as for creative environment in hardware and software.

As said earlier, the basic requirement to enter these institutes to do B. Tech. varies from institute to institute. Apart from the Joint Entrance Examination, the candidate must have finished his +2 stage. There does not seem to be much demand for M. Tech. programmes. Though more than twelve institutes and universities offer these courses, not many go in for them. One of the main reasons being overlapping of syllabuses between the B. Tech. and M. Tech. courses. Students who do B. Tech. in relevant subjects find that in M. Tech. they have to do much the same course they did in their B. Tech. course.

Institutes offering B. Tech. in Computers

IIT, Delhi
IIT, Bombay
IIT, Kharagpur
IIT, Kanpur
IIT, Madras
Roorkee University
Jadavpur University, Calcutta
BE College, Calcutta
Regional Engineering College, Warangal
Regional Engineering College, Tiruchirapalli, Tamil Nadu
Motilal Nehru Regional Engineering College, Allahabad
Birla Institute of Technology & Science, Pilani, Rajasthan
Banaras Hindu University, Varanasi
Indian Institute of Science, Bangalore
UVC College of Engineering, Bangalore

Maland College of Engineering, Hasan, Karnataka
PES College of Engineering, Mandya
MS University, Baroda
National Institute of Engineering, Mysore
SJ College of Engineering, Mysore
College of Engineering, Anna University, Madras
College of Engineering, Waltair

Institutes offering M. Tech. in Computers

IIT, Delhi
IIT, Bombay
IIT, Madras
IIT, Kanpur
IIT, Kharagpur
University of Cochin
Calcutta University
Jadavpur University
Regional Engineering College, Tiruchirapalli, Tamil Nadu
Osmania University
Roorkee University
Andhra University

Apart from B. Tech. and M. Tech. degrees some institutes also offer B.Sc. and M.Sc. degrees in computer science. "The three years B.Sc. degree in computer science is equivalent to the degree in computer science while the Master's program goes deeper into systems software. M. Sc. graduates cover compiler and interpreter development, software with emphasis on logic and mathematics. They often take up jobs as systems programmers and analysts with the few R & D organizations in the country or seek jobs in advanced countries."

For graduates who want a relevant degree which would allow them to enter the field of computers there are a number of diploma courses started by government institutes. Most are of one year, full-time duration, though some are of a year and a half. These courses are very intensive and the person who is given this Diploma in Computer Application (DCA) is expected to have gained enough knowledge of the computer to be able to analyse data processing problems, construct a well defined program and select an appropriate algorithm.

The year and a half courses have been started by some of the important polytechnics. We give below the list of institutes which offer one year as well those that offer a year and a half diploma courses in computer courses.

Institutes that conduct one year diploma courses in computer application

Andhra University, Vishakhapatnam
Gujarat University, Ahmedabad
Gauhati University, Guwahati
North Bengal University, Darjeeling
Utkal University, Bhubaneshwar
University of Poona
Sardar Patel University, Vallabhvidyanagar
Bangalore University
Kerala University, Trivandrum
Madurai Kamaraja University
Osmania University, Hyderabad
Jodhpur University
Kurukshetra University
Panjab University
Jammu University
Aligarh Muslim University
Hyderabad University
Bhopal University

Institutes that conduct one and a half year diploma course in computer application

Cusrow Wadia Institute of Technology, Pune
JSS Polytechnic for Women, Mysore

Central Polytechnic, Trivandrum
Women's Polytechnic, Calcutta
Meherchand Polytechnic, Jalandhar
Jodhpur Polytechnic, Jodhpur
Berhampur Engineering School, Ganjam, Orissa
Government Polytechnics at Ahmedabad, Bhopal, and Tirupathi
Thyagraj Polytechnic, Salem
Assam Engineering Institute, Guwahati
New Government Polytechnic, Patna
Institute of Engineering and Rural Technology, Allahabad
Government Polytechnic, Panaji, Goa
Women's Polytechnic, New Delhi.

Post-Graduate Course in Computer Applications: This course leads to the Master's degree in computer application (MEA), and is of three years duration. The minimum qualifications for admission to this course are:

B.Sc. in mathematics/physics/statistics/computer science, or
B.Sc. (applied science), or
B.Com. or
any other equivalent qualification.

It is important that the candidates applying for admission to this course must have secured about seventy per cent marks in aggregate in subjects apart from languages. This limit is lowered by ten per cent for candidates belonging to Scheduled Castes and Scheduled Tribes. By considering this requirement, it must be clear that only the best are admitted to these courses. Students who come out of the institutions are easily and quickly absorbed by employers looking for bright and intelligent computer professionals.

The main stress in this course is on data processing in a number of different environments—commercial, industrial, scientific and administrative. Those who complete the course become capable computer programmers who can develop well-structured computer application systems on their own.

Application forms are offerred for sale around May every year and cost Rs 30. The completed application forms are accepted up to July 6, every year. Given below is a list of institutes which offer the course leading to Master's degree in Computer Application:

Delhi University
Hyderabad University
Poona University
Aligarh University
PSG College of Engineering and Technology, Coimbatore
Regional Engineering College, Rourkela
MS University, Baroda
Regional Engineering College, Tiruchirapalli
Thapar Institute of Engineering & Technology, Patiala
BMS College of Engineering, Bangalore
Anna University, Madras
VJTI, Bombay
Motilal Nehru Regional Engineering College, Allahabad
Birla Institute of Technology, Ranchi

For under-graduates there are courses which train them in online data operation. Those completing this course become trained programmer assistants and are able to work in data entry department as well as in word processing, financial accounting, text editing and inventory control. The course is of one year duration and a candidate is eligible to apply after he has completed his class tenth course successfully.

This craftsman level course of one year duration is offerred by the following ITIs, each of which is provided with an ECIL micro 32.

National Vocational Training Institute for Women, New Delhi
Central Training Institute for Instructors, Madras
Regional Vocational Training Institute for Women, Bangalore
Regional Vocational Training Institute for Women, Bombay

Advanced Training Institute, Hyderabaad
Advanced Training Institute, Kanpur
Industrial Training Institute, Rae Barelli
Industrial Training Institute, Hyderabad
Industrial Training Institute, Lucknow
Industrial Training Institute, Hissar
Industrial Training Institute, New Delhi
Industrial Training Institute, Pondicherry
Industrial Training Institute, Vishakhapatnam

Part-time courses

For those unable to join full time courses there are courses in computer technology offered by government institutes. But these courses are extremely inadequate in terms of what is needed. Given below are some of the part-time courses :

1. All the Indian Institutes of Technology offer some course or the other in computer technology on part-time basis. However these courses are offered only to those who have at least some knowledge of computers. Some of the seats in these institutes are reserved for those who are from educational institutions.

2. The one year part-time course offered by National Centre for Software Development & Computing Techniques at the Tata Institute of Fundamental Research, Bombay, is highly valued. It has its own computer systems—DEC 10 and DEC 20—and gives extremely valuable training, covering areas of systems analysis, database management and elements of graphics. It is organised to impart training to only sixty students at a given time and competition for admission to this course is rather tough.

3. Indian Institute of Science, Bangalore, is another important institution offering part-time courses. It imparts training in the use and understanding of some of the computer languages and introduction to microprocessors.

4. CMC Ltd, a government of India undertaking, is yet another important organisation imparting training in computer technology at various levels. However, most of its part-time ccurses are meant primarily for computer professionals who wish to keep themselves abreast of the advances in computer

technology. Almost all of its courses are short-term (running into a few days) and are highly valued.

The courses offered by these institutes, though highly valued in terms of their emphasis on genuineness, are extremely inadequate. Today, there are supposed to be only 40,000 computer professionals in the country (which is, again, extremely inadequate). The country is expected to need over 2,00,000 computer professionals every year (and this is just a conservative estimate, with the demands expected to be much). Obviously the government institutes cannot meet this demand for training such a large number of computer professionals. The interaction between demand and supply is basic to the nature of life. And so is the case with this problem. In the absence of establishment institutes, private institutes have mushroomed—some excellent, some good, some bad, and some outright cheating houses.

The moment you decide to take a course in computer technology in one of the private institutes, you will notice one thing. Each institute advertises its course (todays newspapers are carrying ample number of advertisements from these institutes, each offering something which is exclusive to it) in as diverse a way it can possibly do. Consider the following, taken from one of such advertisements:

> ...offers well designed and highly job oriented computer courses (1) Post-graduate Diploma in Computer Programming and System (?) Analysis—8 months—(for graduate and above) and (2) Certificate Courses in BASIC/COBOL/FORTRAN/PASCAL/d'BASE/II/WORD PROCESSING (for all)
>
> Complete practical and professional training is given on the three latest in house computers.
>
> Guaranteed job assistance is provided on completion of the courses. Courses are conducted by highly qualified computer professionals.
>
> Exhaustive study material are supplied
>
> Library facilities exist, with latest books
>
> Merit scholarships are awarded to bright students
>
> Convenient batch timing available in morning/evening/day (with 500 students capacity every day)
>
> Personalised and individual attention given to each student

Concessional accommodation arranged for outstation candidate . . . .

After reading this, you will notice that there is hardly anything which the advertiser has missed in terms of what the institute has to offer. This may antagonise some readers, some may find it up their street and some may be quite indifferent towards it.

Then there are the fees. After seeing the advertisements if you decide to see for yourselves what these institutes are, you will notice another common aspect. They charge high fees, which could be as 'low' as Rs 1,500 to as 'high' as Rs 6,000 for a six-month course. With so much of money involved, it is but natural for the student to choose his institute with extreme care. This becomes even more important when one has to choose a short term course (running from six to eight weeks) with fees ranging from Rs 1,500 to Rs 3,000. It is another matter that we see such exorbitant charges are mainly due to the absence of any government machinery which could control or coordinate the running of these institutes and the fees they charge. Let us now consider the syllabus covered by these private institutes.

Fundamentals of computers are obviously the common element of these courses offered by private institutes.

Programming languages is yet another common element you will find when choosing a course

Some of the institutes also cover training of organisation as part of their syllabuses

Systems analysis

Data processing

Special topics

Special applications.

Among the better institutes, you will find courses on:

Office automation

Introduction to EDP

Introduction to microprocessing

Programming in BASIC or COBOL, or both

Computer graphics

Programming in FORTRAN, PL/1, etc.
Systems analysis and design
Commercial application of computers

At this point, we may ask ourselves why private institutes in this field are such big crowd pullers? The reason why private institutes in this field in spite of their major as well as minor inadequacies, are successful is because of the career potential of computers. With every passing day the need for computer professionals is increasing. In their own limited and inadequate way, private institutes are catering to that demand. Institutes may have no intention of providing properly trained professionals.

However, in spite of all their faults, the private institutes are keeping the computer revolution alive in the country. But for them this simply would not have been possible. For, were the field of computers to depend only on government run training establishments, the computer revolution would never have taken off. For to keep a revolution alive, it has to have new and more members joining it all the time, which would not have been possible with the limited output of trained computer professionals of these institutes.

The training imparted by private institutes is extremely inadequate. It does little to give confidence to its students for handling the job properly even if they do get employment. But there is something to compensate for this inadequacy. Many of the private institutes offer employment of placement service to those who get training from them. This acts as yet another "bait" to attract more students.

The Government Institutes vs Private Institutes

1. Courses run by government institutes are highly structured and provide knowledge of the basic sciences and abilities associated with computers.

The emphasis of a private institute is to impart quick and practical training in the field of computers. The main aim of these courses is to enable the trained person to get a suitable job in the field.

2. The jobs that one can choose from after training in government institutes are of "higher" variety than those that can be from training in private institutes. The person who

comes out successfully from the government institutes can expect to be employed in computer research and development, systems analysis and management. These jobs have obvious advantage of better working conditions and higher salaries.

On the other hand, employment potential for those with degrees and diplomas from private institutes are extremely limited. Most end up with only a computer programmer's job, which is at the most a little more important than the lowest rung of the field. It is another matter that with more training these programmers can expect to climb up the employment ladder.

3. Most of the courses run by private institutes can also be taken as an appreciation course for those with no knowledge of computers. Such courses are extremely useful for prospective computer users who are not acquainted with them.

The government institutes have very little to offer in this sphere.

4. It is very easy to know about the basic structure of the courses run by government institutes. This is very useful to know and choose the course one wants to take up.

This is not very easy in the case of private institutes. Not many of them are forthcoming in the subjects they teach since no standardization is followed by this section.

5. The government run institutes have the implied stamp of official recognition and are accepted by all government departments and well established private organizations, when they look for prospective employees.

The private institutes have this inherent disadvantage. For they have no government recognition and employers take their students only after they have failed to get someone from government institutes.

How to choose a course?

Once a decision has been taken to do a course in computers, the problem arises as to which course to take. This problem is confined mainly to courses offered by private institutes. For in the case of government institutes, the problem is not which course to take, but which institute one goes into. This is so because all the government institutes running the same course have the same syllabus. And, at different levels, the requirement of admission is different and admission to various courses is mostly through admission tests and in some cases through admission tests and interviews. Since, degrees or diplomas belong to separate levels, what one wants to do differs from level to level. For example:

1. If one wants to do craftsman level courses in computers, it is futile to think about IITs and other such institutes. These institutes have nothing to do with these courses run by the IITs and one has to consider the educational requirements for admission to these courses and what such a diploma will lead to in terms of potential.
2. For those who want to do a diploma course after their graduation, the right thing is to look for institutes which offer such courses. Investing investigating offering graduate or postgraduate level degree courses is a waste of time. Even in the case of institutes offering diploma courses in computer application, the best thing to do is to decide whether one wants to do a one year course or a one and a half year course.
3. For those who want to do a proper, full time course in computer leading to a graduate and/or postgraduate degree, one has to look for dates for admission tests which enable entry into the IITs and other similar institutes which offer courses leading to graduate and postgraduate degrees.

Thus one has to define the purpose and on the basis of that purpose, check the educational qualifications that one has or is about to have and then decide about the course to take.

In the case of private institutes, the choice is not so simple. With almost every institute offering almost all types of courses for those with almost any type of qualifications, it requires careful planning to decide about the course one should take and the institute one should go into.

Let us take, step by step, the things you have to do in deciding about the course you have to take and the type of institute which can provide you with proper training in that course:

1. Consider your educational qualifications and your age. Both are important. A fifteen-year-old boy, with just tenth class certificate has no hope to go in for the training of systems

analysis. He has to think of ITI level courses and then look for an institute which imparts training in that course.

2. Consider your future objectives. If you want to be a pilot when you grow into adulthood, a training in computer programming will not be very useful to you. However, if you are young and have decided about a career in computers, you will be well advised to do a course which introduces you to the world of computers.

3. Once you have decided on the course you wish to take; you must collect as much information as you can about institutes which offer courses of the type you want. This will not be easy. But you can achieve your objective by closely following the advertisements that appear in newspapers and write to them for details about the courses offered.

4. Once you have got all the literature that you need for your course, look carefully about the faculty which any reasonably good institute will give in its prospectus. Look for the qualifications that each faculty member has. Is he qualified enough to teach you successfully? Even if you do not have knowledge about the qualifications which make up a good teacher in the field, you can have a general idea about his qualifications by looking at the degrees/diploma he himself has and from the universities/institutes from where he qualified. You can also discuss this subject with some of the senior members of your family or your teachers (past or present).

5. You must find out the type of computer the institute has, if it has one You should prefer to join institutes with their own computers. Without a computer a computer training centre is not very good and there are bound to be much descrepancies between what it promises and what it gives. If an institute is using a computer on time-sharing, it has to have a well defined schedule to let each and every one of its students enough time with it. You must be sure of what you are likely to get before you choose an institute.

6. While going through the literature on private institutes, you will notice that many have placement service for those who join them. You must find out the extent to which this is true. And also about the type of placement one can hope to get. This information may not be easy to come by and you will require all

the tact and ingenuity to extract this information. For the main reason why you are doing this short term, intensive course (all private institutes have short term courses) is to get a proper employment in the field of computers. You must know the kind of jobs the institute can help you find once you complete the course offered by it.

As you go about collecting information about the courses which are up your line of objectives and educational qualifications, you will notice that in whatever institute you go, you find some difficulty or the other to get the kind of information you want and must have to be able to decide in the best possible way about the institute which can give you what you are spending so much money for. Even after getting the information you may not be sure about the extent to which it is correct. The best thing for such a case is to read an introductory book on computers which can guide you about what to expect in doing a course on computers. A book requires a few days to read, costs very little and can turn out to be a good investment in terms of time and money. If nothing else, it will have told you 'something' about the field of computers, which is certainly better than groping in the dark.

3

Types of Jobs in the Field of Computers

If you are a regular newspaper reader, you will have noticed that every day newspapers carry at least half a dozen advertisements, from employers seeking computer professionals of one kind or the other. These advertisements tell us about what employers need today. They tell us about what prospective employees should have in terms of training and experience to be successful in getting the type of job they want. They also tell us about what employers are ready to offer in terms of working conditions and monetary package. Given below is such a list of job openings in the field of computers.

Systems analyst
Computer programmer
Data entry operator
Systems manager
Training manager
Training instructor
Sales executive
Technical support executive
Field engineer
R & D professionals
Marketing trainees
Systems engineer trainees
Console operator

Director EDP (Electronic Data Processing)
Manager EDP
Data centre manager
Data base administrator
Assistant general manager (Systems)
Manager (Systems)
Data base analyst
System software analyst
Programmer analyst

This is just a random listing. There are no superiorities or infiriorities invloved. It is just to give you some idea about the types of employment openings which you can expect in this field and the requirements which you must fulfil to be able to succeed in getting the kind of job you want. He will take them up in turns.

Systems Analyst

Educational qualifications: A university degree preferably in computer science or engineering degree followed by professional training in systems analysis and programming.

Other requirements: Four to six years experience in developing and maintaining large applications.

Expert knowledge in one or more of the computer languages. In addition, knowledge about assembler/microcomputer operating systems, gives a distinct advantage over competitors.

Salary: As an important post, it carries a rather impressive monetary package. Rs 3,000 to Rs 6,000 per month salary, plus perquisites.

Computer Programmer

Educational qualifications: These vary from organisation to organisation. As in the case of systems analyst, this also requires qualifications of a programmer because a systems analyst is by implication expected to have the qualifications of a programmer too.

However, if an organisation needs only a programmer, it is most probably looking for a person who is a graduate in any discipline, has a diploma in computer programming from a well known institute and has already worked in some capacity in a computer programmer.

It is to be borne in mind that all good organisations, offering good pay and working conditions prefer people with some experience in the work for which they are employed. A person with experience has a distinct advantage over a person with no experience. This however is not a rigid condition and many a time a good, trained person with no experience has been preferred to a trained and experienced person.

Another basic qualification for this job is knowledge of at least two of the important computer languages. Among them COBOL, BASIC, FORTRAN, PL/1 are considered important.

Salary: The salary offered to a computer programmer differs from organisation to organisation. In the case of advertisements from private organisations you will notice that they very seldom mention the salary and other employment benefits. This is so because most are business organisations and they keep other organisations from knowing anything about them. Moreover, they do not have any fixed grades as in the case of government departments and the salary they offer depends on one's capabilities and bargaining ability. However, a computer programmer can expect Rs 1,500 to Rs 3,000 from a good employer. In government departments, a computer programmer is likely to get Rs 1,000—Rs 1,850, which will give him a starting salary of Rs 1,633.

Data Entry Operator

Educational qualifications: A data entry operator is a junior level computer professional. A person desiring to be a data entry operator must be a graduate in science and must have a training in data entry. Most organisations also insist on some experience in the field.

Salary: Here also, salaries differ from organisation to organisation. But these generally range between Rs 900 to Rs 1500.

The government departments take data entry operators in a pay scale of Rs 575—Rs 880, which gives a starting salary of Rs 939 per month.

Systems Manager

Educational qualifications: This is a senior posting. To be a systems manager a person should be

(a) A Ph.D. in the field, with three years experience, or
(b) An M.E./M.Tech with five years experience, or
(c) A.B.E./B. Tech./M.Sc. in computer science or electronics or P.G. Diploma/M.Phil. in computer science or operational research, with eight years experience, or
(d) An M.A. (in mathematics/statistics/operational research/economics)/M.Sc./B.E./B.Tech./with nine years experience.

Salary: The salary of a systems manager is certainly more than that of computer programmer. It is closer to that of the systems analyst. The minimum salary in this case should be Rs 2,500 and the maximum, Rs 4,000. But there are no hard and fast rules. A person standing as a systems manager in the government department will be placed in the grade of Rs 2,000, which will give him a starting salary of about Rs 3,036.

Training manager

The status of a training manager in an organisational hierarchy of a firm is almost the same as that of the systems manager. He gets almost the same salary and other benefit package as the systems manager. The requirement in terms of education are also the same as those of systems analysts.

Training Instructor

Educational qualifications:

a) A.B. Tech,/B.E. or M.Sc. in computer science/electronics, or
b) A Post-Graduate Diploma in computer science or with a M.Phil. in the same subject or operations research, or
c) M.A. (mathematics/statistics/operations research/economics)/M.Sc./B.E./B.Tech., with one year experience.

Salary: Training instructors function under the supervision of training managers. A training instructor can expect to get the salary of a computer programmer, which is between Rs 1,500 and Rs 3,000, alongwith other benefit package like dearness allowance, house rent, etc.

Sales Executive

As in any field with a vast market to be tapped, the field of computers too holds promise for the future. Those who want to make selling computers their career will find that the pay is very good, the educational requirements not too rigid and there is much variety in the kind of things one would be selling in connection with computers. For example, apart from selling actual computer hardware there is much future in selling peripherals, accessories and segment specific software packages. In other words, the whole computer field is wide open to those who have a flair for sales and are ready to rough it out.

A sales executive in the field need not have any specific, technical training. A graduate with ambition to make sales a successful career and a few years experience in industrial selling stands a good chance of succeeding in terms of monetary benefits and work satisfaction. A sales executive may start with Rs 2,000 and, in most cases, a commission on the value of what he sells.

About other qualities, this is what one employer wanted: "Applicants (applying for the post of sales executive) must possess a pleasing personality with good communication skills to effectively interface with middle and senior management personnel. The position calls for extroverts with an inclination for aggressive selling and the capability to coordinate after service support to customers. Selected candidates would benefit from comprehensive product training before commencing field sales activities."

A result oriented person for this computer field has an extremely bright future.

Technical Support Executive

This position is almost at par with the sales executive's job in terms of monetary benefits, though in some organisations a technical support executive may be considered slightly lower in the organisational hierarchy.

What does a technical support executive do? After the sales executive gets the order from a customer, it is the selling organisations' job to install the hardware to customer's satisfaction. This is where the technical support executive comes in.

Normally, the technical support executive is a graduate with some experience in hardware maintenance. However, every organisation can frame requirements to suit its specific needs.

Salary: A technical support executive gets about Rs 1,500 with other benefits, per month.

Field Engineer

Educational qualifications: To be a field engineer, a person must be electronics engineering graduate with minimum two years experience or diploma holders with minimum four years experience in field maintenance of microprocessor based systems. Candidates with experience in computer field maintenance are preferred. The job involves maintenance of computers at customer locations.

Salary: The field engineer's position is at par with the technical support executive—though some organisations may consider one slightly higher than the other—and the monetary and other benefit package offered will be almost the same as that which is offered to the technical field executive.

R&D Professionals

Research and development, as the name suggests, is concerned with not only development of existing computers and also inventions of new ones, it also means adapting computers coming from other countries or manufacturing them in India under technical collaboration, to the specific needs of the country. For example, adapting electronic typewriters to the needs of Hindi was the result of the work done in the research and development departments of the companies manufacturing electronic typewriters in Hindi.

As the following advertisement shows an organisation tries to attract suitable people to its research and development departments.

"We offer you an opportunity to be part of the network that inspires our R&D professionals.

Ample availability of computer development systems tools, test equipments and CAD facility.

Informal atmosphere and open door policy which fosters growth.

Attractive compensation benefit and programme commensurate with experience.

Library with leading international computer publications.

Advanced projects covering computer hardware, operating systems, compilers, communications, graphics, CAD/CAM.

Accelerated progression for exceptional performers.

Facility for creative research projects.

Opportunity for training abroad and job rotation.

Assistance to pursue professional course, subsidy for purchase of technical books."

Salary: There are no fixed guidelines. The salary that a person gets depends on his educational qualifications and experiences, if any, and also on the level to which he is appointed. This is one department with maximum job security. For no organisation likes to lose a good, result oriented research and development professional. Some organisations go out of their way in trying to retain them. Salary here can begin at Rs. 2,500 and can rise to a gigantic level.

Marketing Trainees

This is a scheme for those who want to make selling their career in the field of computers but have no experience.

Educational and other qualifications: "Applicants must be graduates/post-graduates in engineering (any discipline), management, mathematics, physics, or statistics. Position calls for high degree of initiative, persuasiveness, assertiveness and excellent communication skills.

"Those selected will undergo an extensive six weeks residential training programme. After a short on-the-job training, candidates will be involved in field selling and would be responsible for achieving independent targets."

Salary: Marketing trainees are likely to get Rs 1,500 from the day they join the organisation and soon start getting Rs 2,500 plus other benefits, depending on how successful they are at their job.

Systems Engineer Trainees

This scheme is best suited to those who want to become field engineers and technical support executives but have no experience.

Educational and other qualifications: "Applicants must be

B.Tech/M. Tech. in electrical, electronics, computer science, systems and management or MCA. The job requires high degree of conceptualization and involves variety of newly released software modules/systems guidance in a consultants' mode, to act as a 'facilitator' to clients on EDP and computer usage. Systems analysis and design programming, development of standard and non-standard scientific and business application packages, training, hardware and software configuring and trouble shooting. Knowledge of COBOL/BASIC and familiarity with UNIX/'C' would be an advantage."

Salary: A systems engineer trainee is at par with the marketing trainee and his salary is the same as that of the marketing trainee.

Console Operator

The console operator is needed for electronic data processing.

Educational qualifications:

1. Master's degree in computer science, or
2. Master's degree in operations research, or
3. Master's degree in statistics, or
4. Master's degree in physics, or
5. Master's degree in mathematics, or
6. Degree in engineering.

With these, the person must also have some experience of electronic data processing, computer programming, systems design and systems analysis.

Director (EDP) electronic data processing

Such posts are normally advertised by government departments which have planned to install a computer or already had one and need some one to look after the department.

Educational qualifications:

1. Master's degree in computer science, or
2. Master's degree in operations research, or
3. Master's degree in statistics, or
4. Master's degree in physics, or
5. Some equivalent qualifications.

Alongwith one of these qualifications, the person must also have worked in related fields of electronic data processing, computer programming, systems design, or systems analysis, for over ten years.

Salary: For a government department such a post is quite high in the bureaucratic ladder and carries adequate monetary as well as other benefits. A director (EDP) will get a salary grade of Rs 2,250, which will give him a starting salary of Rs 3,757.

In a private organisation the salary and other benefits would be decidedly more.

Manager (EDP)

This post is only marginally lower than the one mentioned above. Educational qualifications:

1. Master's degree in computer science, or
2. Master's degree in operations research, or
3. Master's degree in statistics, or
4. Master's degree in physics, or
5. Master's degree in mathematics or
6. Any other equivalent qualification.

Alongwith any one of these qualifications, the person must also have experience of electronic data processing, computer programming, systems analysis, and systems design; of over seven years.

Salary: A manager (EDP) gets a pay scale of Rs 2,000, which gives him a starting salary of Rs 3,069 per month.

Data centre manager

This post is at par with the post of director EDP.

Educational qualifications: A person desiring to be a data centre manager must be a post-graduate in engineering or management, with about five years experience in the relevant field.

Salary: If a private concern appoints some one to this post, the person can expect to get anywhere from Rs 3000 to Rs 5000 per month, depending on the type of organisation. In a government organisation, he is likely to get a salary which is only marginally less than that of director EDP.

Data Base Administrator

This post too is almost equal to that of director EDP.

Educational qualifications: Since the job involves effective implementation of certain software on certain hardware and development and auditing of all application software systems, the educational qualifications are:

Post-graduate diploma or degree in computer science, management, industrial engineering, or any other equivalent qualification, with specialisation in systems management.

Salary: A person appointed to the post of data base administrator will get a salary in the grade of Rs 2,050 with increments of Rs 80 per year till the basic scale becomes Rs 2,450. But such information is of value to a person who is already employed. However, the starting salary—including all the allowances applicable to the scale—of a person appointed to this post would be Rs 3,357.

Assistant General Manager (Systems)

This post is at par with the one mentioned above, both in terms of educational qualifications and experience required, with some exceptions.

Educational qualifications: Post-graduate degree or diploma in computer science/management industrial engineering with specialisation in systems management.

About "ten years experience on a large computer system in an engineering company in planning, coordination, execution and monitoring of computerised systems."

About the job responsibilities, this is what an employer says: "(He) will be responsible for development and implementation of business/engineering application systems, and effective usage of data base and other available computer facilities."

Salary: The salary in this case would be the same as that of the data base administrator.

Systems Manager

A systems manager is almost like a systems analyst. He is responsible for designing, developing, implementing and other relevant assignments connected with the computer system of the organisation.

Educational qualifications: The essential qualifications in this case are a graduate degree in engineering or computer science or a post-graduate degree in mathematics or statistics. About eight years experience in electronic data management.

Salary: A systems manager gets about Rs 3,500 or above as his starting monthly salary at the time of his appointment.

Data base analyst

This can be said to be a post between junior level management and middle level management—that is, a little lower than the middle management and a little higher than the lower management

The work of the data base analyst includes designing, implementing, and maintaining data base systems.

Educational qualifications: A post-graduate degree in computer science, management, industrial engineering with specialisation in systems management. Most organisations also want people to have some experience in the work.

Salary: The starting pay of a data base analyst should be around Rs 2,500 per month.

System software analyst

The job of the system software analyst is in many ways similar to that of the technical support executive or the field engineer.

Educational qualifications: Post-graduate qualification in computer science and some experience of the work.

Salary: This post is equal in importance to the post of data base analyst and carries the same salary.

Programmer analyst

The programmer analyst is slightly superior to the computer programmer and is expected to "design, develop business application programs in production planning and control, inventory control, management information system, marketing, finance and design/methods applications."

Educational qualifications: A graduate in engineering with a few years experience in the field.

Salary: A programmer analyst is expected to get a salary of Rs 2,250 and above.

Teacher/trainer

This again is a field with enormous potential in terms of career. As the use of computer increases, so would the need for people who can teach people and train them for work.

A person who wants to be teacher in the field of computers must be at home with computers in the most comprehensive way. For a well-qualified person, with enough experience, computers offer an extremely rewarding as well as satisfying field.

How much can a person earn as a teacher in this field? He can get a little more than the established teacher, if he prefers to teach in a government institute. If, however, he prefers to start out on his own and open a training institute to train computer professionals, there is virtually no limit how much he can earn. A teacher wanting to open his own training institute would need to have a sense of enterprize and the self-confidence which is essential for a person who wants to be his own employer.

We hope this section has given you enough idea about the career potential of the field of computers and the variety of jobs that are available to a person looking for a future in this field. We have deliberately not given a hierarchical order in our description of various posts in this field because we want you to study each and every opening in this field in terms of the educational requirements, experience (if any) required, work involved in each part and the monetary benefits that are offered by each opening. One has a tendency to study only what is of immediate concern to him. Thus, chances are, you would study only the first few openings which are of immediate concern to you, if we describe the available openings in their proper hierarchical order. This is not the case, and you will have studied the whole chapter to know what you want. This in turn will enable you to be familiar with the entire field and the career prospect that it has to offer at various levels, and you will be able to plan your future in the best possible way.

4

About Getting the Job

After you have gained enough knowledge about the field of computers and have acquired the requisite educational qualifications, and have made a brief yet comprehensive survey of the various levels of employment in the field, how should you go about getting the job?

First rule: Do not wait for proper openings to be advertised in various media. Once you feel that you have attained enough knowledge and qualifications, you should start contacting organisations which you think can be your potential employer. Do not go personally. You do not have to knock at the doors and beg for jobs. What you should do is to write a letter introducing yourself. In the letter you must furnish the following information:

1. Your name and address;
2. Your date of birth;
3. The educational qualifications;
4. Extra-curricular activities you were interested in while studying;
5. Special training, if any;
6. A list of the names and addresses of at least three persons not related to you, who are well qualified to vouch for your character and capabilities;
7. The type of work that you can do and want to be employed in.

The letter that you write must be brief, to the point and clear in its meaning.

Most organisations have a personnel department, in the charge of a personnel manager or officer. Your letter must be addressed to him. Having sent the letter, desist from sending reminders. No organisation welcomes reminders about job applications, though they may appreciate a letter of introduction from a prospective employee. If the organisation is interested in you, be sure that you will hear from it. For an organisation needs a good employee as much as a person needs a good employer.

Second rule: Having written your letter requesting employment, you should not wait. Keep seeing the newspaper for any job advertisement relevant to you in terms of your educational qualifications. If there is a public library close by, you can go there regularly and sift through the newspapers for job advertisements. This is so because most houses get only one newspaper on regular basis and going to the public library will allow you to go through other newspapers which do not come to your house but are relevant to your objective.

Apart from the daily newspaper that you get, there are some publications exclusively for those seeking employment. The Government of India brings out *Rojagar Samachar* on regular basis. Some of the weekly magazines and periodicals also carry employment advertisements. You should consult all if you can lay your hands on them in the library. *You must remember that once you have attained the requisite educational qualifications and other requirements, you have to work full time.* In the beginning you have to work full time to get the job. Once you get the job, you have to work full time to keep that job.

What kind of job advertisements are you likely to see? Some employers give all the relevant details and the work an employee would be doing. Some give only the highlights and keep their options open in terms of the kind of person they want. Sometimes, employers may prefer a person who fulfils all their requirements but is either under-age or underqualified. Such employers find it difficult to do what they want if they do not keep their options open.

Sometimes you may not get appointment straightaway. You may instead be admitted to *traineeship schemes* of various organisations. Traineeship schemes are very useful for people who have the educational qualifications but no experience and hence find it difficult to get a job. A traineeship scheme is the kind of training which lets the trainee get firsthand training of the job and also be an employee of the organisation for all practical purposes. Quite a number of employers take more persons than they eventually need in their traineeship schemes. In such cases, the surplus trainees are obviously asked to leave once their training is over. Thus, if a person fails to get a job after having served in the traineeship schemes of the organisation it does not mean that he is inferior in capabilities to those who succeeded in getting the job. Traineeship schemes are excellent to get the required experience. During the training period, the candidate is exposed to all the work that a person in actual employment does. This gives him excellent opportunity for gaining necessary experience. Most traineeship schemes last from six months to twenty-four months. Starting stipend may be from Rs 750 to Rs 2,000 per month, with necessary increase after completing the stipulated training period, eventually getting absorbed in the appropriate level of the hierarchy and getting adequate salary and other benefits.

There are also instances of people already doing a job in an organisation and then getting transferred to another job, more important in terms of monetary gains and respect value. This is true in the case of computers, since there is a shortage of trained personnel in the field and organisations tend to prefer their own employee who has already been working in the organisation and has been able to get the necessary training in the field through his enterprise and hard labour. What is more, when faced with two candidates who are equally qualified but one of whom is already working in the organisation in some capacity, normally gets preference, since the employer is already familiar with his attitude towards work and his character.

This aspect of entry into the field of computers is very important since training is given after office hours in most cases and often the organisation itself sponsors the candidate who is working in it and has shown inclination for computers.

Briefly, entry into the field of computer can be gained:

1. Through traineeship schemes;
2. Through job advertisements;
3. Through writing letters to prospective employers; and
4. Through extra training.

However the basic question remains. How does one apply for a job? There are many 'ifs' and 'buts' involved in the question and any thing can go wrong any where and a prospective employee may lose his chance. Though there is no guarantee for success in getting a particular job, there are some ways which can maximize your chances of getting that job. First of all, you know how to apply for a job.

Applying for a job

Once you have decided about a job, you must ensure that you are doing the right thing and that you are not about to waste your prospective employers and your own time. Though you may not mind wasting your time, the employer does and if he gets an improper application the effort may well turn out to be a complete waste. To maximize your changes of getting a job you must first make a proper inventory of your qualifications and experiences (if any) which would make you eligible for the job you are applying. You must study the advertisement (if you are applying in response to that) very carefully. Any good organisation will give a good advertisement and every good advertisement will give you all the necessary information about the organisation and the nature of the job for which applications are invited. You must never take the advertiser for granted. Apply only where your applications are needed.

In case you are applying by writing a letter and not in response to any advertisement, you must write only to those organisations which fit the bill most accurately. That is, you must make preliminary enquiry about the job potentiality of the organisation and only when you are satisfied that there is some possibility of your getting a job must you venture to write a letter seeking employment.

In case you are already working in the organisation and seek a change of work, the task is quite easy. Since the employer already has the relevant information about your qualifications, etc., all you have to do is to let him know about any new training that you have undergone and write a letter seeking change of work. Most progressive organisations want their employees to improve their qualifications so that they can be absorbed in various higher strata and save the rigour of seeking fresh applicants. This however does not mean that employers do not like or do not want fresh talent. It only means that, they would like their employees to reach higher status in the organisational hierarchy.

Once you have gained all the relevant information about the job and the organisation in which you are applying, you must mould your basic attitude. You Must be Positive. You must be enthusiastic. You must be honest. You must be free from your own needs enough to be able to present yourself to the employer in ways in which you will become useful to him much before you make him useful to you. For once you have proved yourself useful to him, rest assured that in time he will be more than useful to you.

When you have noticed the advertisement and found it suitable to apply, you will have to write an application informing the advertiser that, on the basis of the educational qualification and experiences (if any), you wish to be considered for the job. This application is a very important document and deserves all your attention. Only then can you draft it in such a way that it not only elicits a reply, but it elicits a positive reply. Only if the application is good and proper that an employer would decide to call you for an interview before actually offering the job to you.

We give below some of the points which you must keep in mind when drafting an application for a job:

1. The letter must be very neat and simple. By trying to impress the employer by your knowledge of English language and include some very difficult and obscure words and expressions you will be losing out on your selection for the job. Remember, even for the specialists job the application that the employer wants is simple in approach and neat in appearance.

2. Be very careful about grammar and spellings of the words contained in your letter of application. You are well advised to keep a dictionary close to you so that whenever in doubt you can refer to it to find out whether a word is correct

or not. A good dictionary would also guide you correctly about the grammatical aspect of the language in the letter.

3. Do not be inclined to narrate your life story. No employer is interested in it. An employer wants to appoint a person to do a job and for that reason is interested in your qualifications and experience. Your application must be as impersonal as possible. Mention only those facts which are of immediate concern to the employer.

4. You will be well advised to make a rough draft of the application and get it checked by your parents or teachers, if you are in doubt about its correctness. By making the rough draft you too will be able to remove some of the mistakes which would have gone unnoticed if you had sent the original draft itself.

5. Always keep one copy of the application with you. This is very important. If you are called for the interview, the copy will tell you the details asked for and provided with when you sent the application.

Writing an application for a job may be good if you were to apply to only one or two prospective employers. But this is not so at the beginning of one's career when you have to apply to a number of organisations and it is not possible to draft a fresh application for each job. Then is the time when you need to draft a general list of qualifications, experiences and extracurricular activities. This is known by a number of names. Most of us call it by the name of 'Bio Data'. The standard format of this document is simple. It contains, in order of appearance, details about:

1. *Your name and address*: Give your full name and current address. Unless asked for specifically, there is no need for giving your permanent address, which may be different if you are living away from your ancestral home. Most organisations are interested in only your postal address at which they can communicate with you if they want to. Permanent addresses are normally sought by government departments, in which case you have to give both the addresses, present (which is your postal address) and permanent (which proves your bona fides as an Indian citizen.)

2. *Your date of birth and age*: Most organizations insist on a specific age limit for a job. Your age is calculated on the

basis of the date of birth given in your matriculation certificate. You must mention only that date which can be substantiated by the relevant certificate. In case your age has also been asked, write the age after calculating it on the basis of the date of birth recorded in your matriculation certificate.

3. *Educational qualifications:* Your educational qualifications must be listed beginning with your first board examination—it could be your matriculation examination or higher secondary examination. Starting with either of the two, go on till the last examination passed. Put briefly, your educational qualification would contain information about these examinations:

1. Matriculation/Higher Secondary
2. Graduation (B.A., B.Sc., B.Tech., etc.)
3. Post-graduation (M.A., M.Sc., M.Tech., etc.)
4. Any other qualification which can be substantiated by a certificate is used by a competent authority.

Under this column, the information that you must mention, are:

1. Name of the examination;
2. Subjects taken and marks obtained in each; and
3. Percentage of marks obtained and division awarded.

4. *Experiences*: If you have worked in any relevant capacity, you must furnish details and the name of your employer, time period within which you have worked and salary drawn. If you have left the organisation in which you were working before applying for this job, then you must also enclose the certificate you obtained from your past employer.

In case work experience is asked for and if your experience falls in that category, this certificate gains added importance. It is also possible that the present employer, if he feels the need for it, may write to your past employer asking for character reference as well as verifying the details which you have mentioned in your application.

5. *Other details*: Under this head will come some of the important extracurricular activities in which you might have participated in your school and college and for which you were awardedprize or a certificate of merit. You may add copies of such testimonials with the bio data.

The bio data must also contain a list of at least three references to whom the employer, should he feel to do so, refer to enquire about your character and ability.

References

Though it is true that not every organisation asks for references, many do. Even among those which do not ask for references, if you furnish a list of references it will be appreciated.

What is the function of references? Why are they needed? When you leave school and college, you are given a certificate certifying the goodness of your character. This is essential in modern times when lawlessness tends to become an end in itself. Though nobody can vouch for anybody's good character fully, one can at least minimize the possibility of selecting a wrong kind of person by insisting on and verifying the correctness of whatever the candidate claims and shows.

The basic purpose of references is obtaining information about the candidate which is not available from anywhere else. Even though the person whose name has been given as a reference hesitates in saying anything critical about the applicant, the experienced employer is able to read between the lines and know the truth which the referee wants to convey but hesitates to do so straightaway.

It is obvious that candidates would give names of only those persons as reference from whom they are sure to get favourable replies. It is also true that perhaps no referee likes giving a bad certificate to a person. However, in the absence of any alternative, the importance of references remains.

In case the references are not asked for either in the application letter or in the application form, chances are that the employer may write to some of the people who are expected to know the candidate and may make his final choice only after he gets a proper reply.

Who can be chosen as a reference?

Educational institutions: For a person who is applying for a job for the first time, the choice of reference would be either the head of the institution where the candidate was educated or some of the senior teachers from that institution. Most teachers are honest and particular about their duty towards their students and give appropriate character certificates whenever asked for. You must give names of teachers who have taught you and are expected to vouch for your capabilities. In case you have taken part in some extracurricular activities, you can also give the names of the staff members who were incharge of the activities in which you participated.

Employer: If you have worked in some capacity in an organisation before applying for the present job, be sure to give the name of your previous employer. In case you are not sure of getting a correct certificate from him, be prepared to give a valid reason—which should not be biased under any circumstances—for it at the time of the interview. Though no employer wants a worker who criticises his previous employer, a good employer would understand the valid reason if given. Your honesty and truthfulness are your best friends. Put them to your advantage.

Reputable citizen: If you know someone who has gained name in his area of activities and is likely to be known to the employer also, you can give his name too as a reference. One of the biggest advantages of such references is that a person who has gained reputation in his field of activities, would never risk his reputation by giving an incorrect character certificate, and such a person has more chances of being believed by your employer than anybody else.

There are two points you must keep in mind:

1. Never give the name of a person as a reference if he is related to you in some way.
2. Always give at least three names as references.

Following are some of the points you must keep in mind while preparing your bio data:

1. Do not make it too elaborate.
2. Do not include everything that has happened to you in school/college. Include only those things which were important in some way and for which you have some proof with you.
3. Do not try and make out an exaggerated Bio Data.

Anybody with some experience, which your prospective employer is bound to be, would be able to see through such an exercise. Even if it passes through initial screening, the reality will come out at the time of the interview. So, keep your record correct, balanced and proper.

4. It is extremely important to get a number of copies of the Biodata that you have prepared. The very purpose of this exercise was to have at your disposal a document which can serve as an employment application and which you could send to all the prospective employers. Give all the care and attention while preparing the documents. After you have given it the final shape, have it typed and a number of copies made.

It is also important that while you are job hunting, you must keep an up-to-date record of all the applications that you have sent and the kind of replies, if any, that you have received. This however does not mean that you will have to write hundreds of letters of application before you get the job that you want. It only means that keeping a record of the applications sent will eventually help you in facing the interview, if you are called for one. It will have the added advantage of training you to be systematic in your dealings with the world at large.

Once you have responded to an advertisement and sent in your application, chances are that you will get an application form to be filled in and to be returned to the advertiser. This is as important a task as writing the initial letter of application. The same care must be given to filling in the form.

The Application form

After you receive the form you should study it carefully before actually starting to fill it. You will perhaps find it difficult to do since the common reaction on receiving the form is to start filling it rightaway. Do not do so. Check yourself. Otherwise you may end up crossing out, changing, or erasing something which you write in a hurry. The study of the form will tell you how to begin and where. It will give you the opportunity to plan your exercise of filling in the form and you will be able to do a good job of it. Each answer that you give in the form must be well thought about before being written. Try and show yourself as a positive personality. But do not overdo it. In other words, honesty does not mean that you list out all your drawbacks in an endeavour to show yourself honest. No employer is interested in your drawbacks. All of them want to know whether you have the qualifications and capabilities to do the job for which you have applied. So, your answers to the questions asked in the form should be clear, to the point and correct.

Other general guidelines for filling in the application form are:

1. Each application form implies following certain instructions. Most carry these instructions, and those that do not imply some. You must pay special attention to these instructions and under no circumstance deviate from them. In the forms that do not carry instructions, the implied instructions include: clarity, factualness, correctness, not leaving any column blank (those that do not have answers must be filled with the words 'Nil' or 'Not Applicable'), etc.

2. Each question in the form must be answered the way you are asked to answer it. With the advent of computers, the answers are expected in codes, which are mentioned in the beginning of the application form.

3. As we have mentioned earlier, your keywords for the filling in of the application forms must be 'clarity', 'simplicity', 'correctness' and 'honesty'.

As in the case of 'Bio Data, try and get one photostat copy made of the filled-in application form so that when and if you are called for the interview you would know the information that was asked from you and which you have furnished in the form. This will eliminate any chance of your being out of context at the time of the interview.

Interview

Once you have submitted the application form, duly complete in all respects, and in course of time have received the intimation from your prospective employer that he wishes to interview you, it is time to know as much as you can about the nature and scope of interviews.

In case you are beginning your career, chances are that you will be asked to appear for a preliminary interview before you are permitted to attend the final interview and selected for the job.

As the number of candidates increases for every post advertised, the importance of the preliminary interview increases. One of the advantages of the preliminary interview is the elimination of certain candidates and by so doing much time and effort is saved, both in the case of the interviewers and the candidates.

Preliminary interviews are by nature short and information is sought and given in a general way, no in-depth interaction takes place. Still, it is no less important. For whether you are called for the final interview will depend on whether you have cleared the preliminary interview.

Once you have cleared this hurdle successfully, you will be called for the final interview though most employers have only one final interview, many prefer more than one. This is specially in the case of the advertiser getting more than the normal number of applications and the difficulty faced in the selection of candidates for the job.

In many ways the final interview can be the most difficult part of getting a job. Each candidate facing interview is nervous, to some degree. You must realise this. Many interviewers too are nervous and restless, to some degree. You must realise this too.

The best way to overcome this nervousness and face the interview successfully is to prepare yourself as well as possible and in the best possible way. Each interviewer prepares himself according to a plan which enables him to judge the person he is interviewing in a way which will give him a worthy employee.

Let us take one by one some of the points which are likely to be emphasized in a typical interview. Why do you want the job you have applied for? This is a very typical question. Why do you want a job in the field of computers? Do you have the training required for entry into the field? Do you have stamina to work in the field? Why do you feel that you will be a success in the field? These are some of the questions which you are likely to encounter when facing the interviewer. So, you will do yourself good if you prepare yourself well in advance by asking yourself these questions and trying to work out the reasons behind your endeavour. If you are honest to yourself and have the perseverance required, be sure that the answer will not elude you for long.

The second important aspect covered in the interview would be your educational background. Why did you choose the subjects you chose? If you failed in some subject or received poor marks, you must be ready with the reasons that were responsible for this. Sometimes a candidate passes one examination with very high marks and then does poorly in the next. If something of the kind has happened to you then you must be ready with an answer which would satisfy the listener. It goes without saying that such an answer would be the correct answer. For no answer can be believable unless it is true. If you are not aware of any specific reason, you can say that too. However, whatever reply you give, never put the blame on somebody else. Even if there is some element of truth in it, nobody will appreciate your pointing it out. An examination is your examination and if you do it properly, the credit goes to you. If you do it badly, you should hold only yourself responsible for it.

Then comes the question of your experience in the field. If it is your first job for which you have applied, there is obviously no question of your having any actual work experience. But, if you can show to the interviewer that even though you have never had the opportunity to work in the field, you have tried and have achieved important training, or have developed the required aptitude for the work, it will go a long way in bringing you success in the interview. Every employer wants a worker who is a selfstarter and work-oriented, and these are the qualities which should show in every activity of your life.

Then comes the question about the type of person you are. Whether your interviewer finds you to his liking will show itself in the very first moment when you enter the interview room (though most interviews are held in rooms, all are not). The interviewer has to convince himself that the person he has in front of him (that is, you) is someone agreeable enough with whom he will be able to work with or with whom other members of the staff would be able to work with.

If you find that you and the interviewer fail to 'click' together, you can assure yourself that if you are not successful it was perhaps for your own good. If the interviewer does not like you, chances are you also do not like the interviewer. It is better in these circumstances not to be taken in by such an organisation as an employee.

You can also tell yourself that an interview is not a oneway street where only the interviewer is expected to ask questions. You too can ask questions but they should be relevant to you and should be asked with politeness. The interviewer should not be made to think that if he can interview you so can you interview him. An interview should not be turned into an inquisition—either for you or for the interviewer.

You will do well to let someone close to you—your friend, brother, sister, one of the parents, anybody in whom you have confidence—give you a mock interview and ask you questions which an interviewer is likely to ask. By doing so you would have worked out your initial nervousness and would be able to face the real interview in a better way than would be possible otherwise.

Apart from paying proper attention to these aspects, you should also pay your attention to the following points:

1. Your clothes should not be something abnormal or conspicuous. Try and avoid wearing brand new clothes as they tend to make you over-sensitive towards them and you are likely to become still more nervous. Your guideline here should be good clothes, which may be old but clean and tidy and not torn or frayed anywhere. Take care to wear formal clothes, your nails should be cut, hair not too conspicuous, and clean looking.

2. You must reach the venue of the interview well in advance of the appointed time. Try and locate the place where you have to be interviewed a day in advance so that you can find out the time it takes you to reach the spot to be able to start from your place at a time which is neither too early nor too late. By reaching a little early you will be able to make yourself at home and will be in the right state of mind when asked to enter the interview room.

3. Once you are inside the interview room, you are face to face with the interviewer. It is more than possible that there are more than one interviewers. Not to worry. As far as you are concerned, you have come for the interview. It should not matter to you if there is one or more than one interviewer.

You must face your interviewer(s) confidently. You must answer all the questions put to you clearly, concisely and truthfully. If you do not know the answer to any question, say so, instead of feeling uncomfortable and restless and awkward. A truthful and honest answer, even if it is negative, is appreciated. However it does not mean that even if you give all your answers in the negative, it will be appreciated. You are expected to know what you have claimed to know in your application and in no interview would you be asked questions beyond that limit. Thus, even though you are allowed ignorance to some extent, you are expected to know the maximum within the area covered by your educational qualifications and experience (if any).

4. Throughout the interview your approach should be positive. You must be confident but should not be over confident and exude cheerfulness. You should be very cordial, respectful, and responsive towards the interviewer. You must show that your interest in the job applied for is genuine and you are confident of doing it successfully if chosen.

If you are careful and pay enough attention to the points explained here, be sure of success in getting the job.

We have explained to you the field of computers in a brief yet comprehensive way. We have described the ways in which you can train yourself for the field. We have given the monetary benefits and other rewards that you can expect from this field. And we have explained to you, step by step, how you should go about preparing yourself for the job, once you have gained knowedge and necessary training in the field. But an important, advice remains to be given. The key to success in any sphere of life, apart from what we have said in the book, is planning. Without planning there is just no hope for anybody. You may get a job in the haphazard way, but you will never be able to keep it if you do not go about doing it in the planned way. If you start planning your career you can achieve plenty and there are no two opinions about it. Only planning can show you the way in which you should proceed, the courses you should take and the advertisements you should reply to.

You must remember that all a book can do is to tell you the how and where of things. It is entirely upto the reader to find out the whys and wherefores. We hope we have done our best. We also hope that you too will do your best. And have a successful and satisfying life as far as your career is concerned.

Career in Computers

Ajay Rai

This book—part of a series on career counselling—is an introduction to the field of computers, the career avenues that it offers, and the ways in which one can acquire basic qualifications for it. It is divided into three parts—computers, education and getting a job—and will serve as a guide for those aspiring for jobs in the fastest growing field for employment.

Ajay Rai is a noteworthy example of a self-made author. Beginning at the age of sixteen with small journalistic pieces, he later went head-long into writing, immersing himself fully in it. The author writes on a variety of subjects, his special interest being in the ever-widening horizon of human intelligence. His style combines the best in heady journalistic writing with quiet sobriety of philosophical comment. Clear, intelligent thinking strikes the reader as the hallmark of the author's writing.

Besides writing in English, his fictional output in Hindi consists of delicately chilling thrillers and subtly futuristic science fiction. His *Intelligence Tests* has been published by Sterling.

He is general editor of the series of books on career counselling.

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